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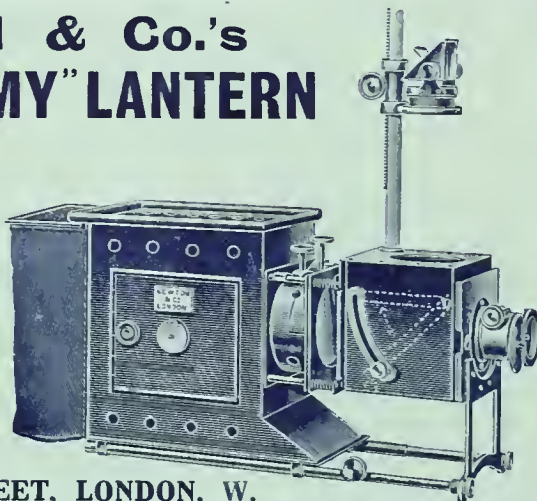
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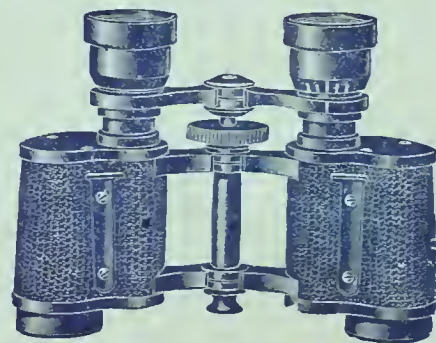
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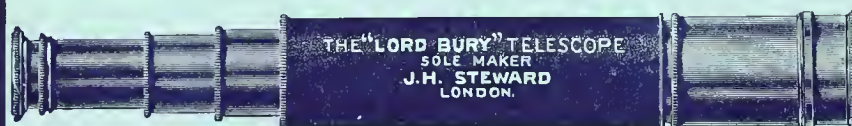
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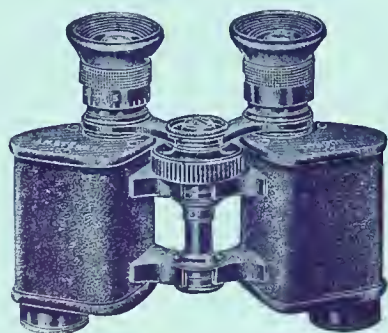
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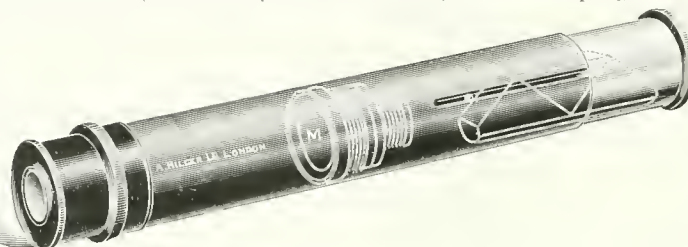
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JANUARY, 1915.

THE HOME OF THE PIGEON-BLOOD RUBY.

By LEOPOLD CLAREMONT

(*Author of the "Gem Cutter's Craft," "Ceylon, the Island of Jewels"*).

THE mineral corundum assumes many aspects. The vast majority of it is opaque and of a nondescript brownish grey colour, and this, on account of the great hardness of the mineral, is used as an abrasive material under the name of "emery." For the same reason small plates of corundum are used as the bearing parts of watches and other mechanical contrivances.

In comparatively rare cases, however, the crystals of corundum are not only transparent, but they are either colourless or they present in separate specimens a long series of different colours of varying shades, which constitute gem-stones.

Distinctive names are given to some of the colours presented by the different varieties of corundum, and thus the blue variety is called "sapphire" and the red "ruby."

For hundreds of years Burma has been famous for producing rubies of the most desired colour.

A perfect ruby is generally described by connoisseurs of gems as being the colour of the blood of the pigeon. It is, however, extremely rarely that a ruby comes to light to which this description can with any amount of accuracy be applied, so that those gems, the colour of which more or less closely approaches this standard of colour, are considered to be proportionately of choice quality.

It must also be pointed out that a shade which may appear to be an approximation to the pigeon-blood colour to the trained eye of one expert may seem somewhat different to that of another; for, after all, the judging of rare gems is merely a matter of opinion, dependent upon the individual appreciation of differences of shade.

The composition of corundum is oxide of aluminium with traces of some metallic oxides, to which the many colours presented by the varieties may be attributed. Although its hardness is greatly less than that of diamond, it is only surpassed in this respect by that mineral. The specific gravity varies from 3.94 to 4.08.

Transparent corundum is doubly refractive of light in all directions of the crystal except one, which exhibits single refraction. It is also dichroic, that is, it does not appear the same shade of colour when viewed through different directions of a coloured crystal. The crystals generally take the form of six-sided prisms or double six-sided pyramids; but these forms are in many cases greatly modified according to the natural laws of crystallography, and, moreover, the crystals are often found in a fragmentary or water-worn condition.

The ruby, or red variety of transparent corundum, is derived from several Asiatic sources, the gems from each of which present a shade of colour which is peculiar to the area whence they are derived, and by far the most important of the sources is Burma.

In the Natural History Branch of the British Museum may be seen a fine example of a large ruby in the natural or uncut condition.

This gem, which weighs over one hundred and sixty carats, was presented to the Museum by John Ruskin in 1887 "in honour of the invincible soldiership and loving equity of Sir Herbert Edwardes' rule of the shores of the Indus."

By permission of the Museum authorities a photograph of the ruby, which is known as the "Edwardes Ruby," is reproduced in these columns

(see Figure 12), showing the exact size of the stone.

Previously to the annexation of Burma by the British Government, the information available to Europeans of the ruby-bearing area was extremely limited, and was dependent upon native traditions and unreliable accounts brought home by a few venturesome travellers to the wild region in which were the deposits of the precious mineral. It was, however, known that for generations the ruby district had been the property of the kings of Burma, the last of whom was the notorious Theebaw, and that the mines were worked by the natives under a system of licences granted for payment, and under certain other conditions, and that some of the licences were hereditary.

Forfeiture to the Crown of any rubies that were found over a certain weight individually was one of the stipulations of the mining licences, and it was suspected that in consequence large stones were broken up by those who found them in order to avoid being obliged to give them up. It is probable, however, that the native miners were unjustly suspected; for, from our knowledge gained of the industry since it has been under European control, we know that even moderately large rubies are of extremely rare occurrence.

Burma came under British control in 1885, and soon afterwards several European syndicates endeavoured to obtain concessions from the Government to exploit the famous gem-bearing district. The tract of country in which the rubies occur lies to the east of the Irrawaddy River, and is about four hundred miles square in extent, embracing the town of Mogok, in the eastern part of it.

In 1889 the Indian Government decided that the concession to search for the rubies should be put up for public tender, and a British syndicate was successful in obtaining it by making the highest bid. This syndicate soon afterwards sold their mining rights to a company entitled the Burma Ruby Mines, Limited, which has carried on the work ever since.

The early days of the enterprise were beset with difficulties, the chief of which was how to get rid of the water which fills the gem pits as soon as they are dug out, and which comes as an inundation at certain flood times of the year. The Europeans suffered terribly from the bad climate, scarcity and pooriness of food, and the want of proper housing accommodation.

Moreover, it was found that those localities which could be worked with a moderate amount of ease were already being worked by native licences, or were under cultivation; and, as it was not permissible to disturb the existing agriculture and mining interests of the inhabitants, the company had no alternative but to turn their attention to the wild and unexplored parts of the country, which consisted chiefly of steep mountain sides covered with dense jungle, the removal of which

was a lengthy and laborious task, attended with considerable danger.

Again and again large areas were cleared of jungle, only to be abandoned, and thus the scene of operations was constantly removed from one locality to another, either on account of the dearth of rubies, or because of the difficulties of carrying on the work proving insurmountable. As no amount of experience of mining gained in other countries was of value under the conditions existing in the Burma ruby area, it was necessary to make a great many trials of different methods, necessitating long delay and great expenditure of energy, before a solution of the problem was found.

Finally, however, success was met by attacking the Mogok Valley by means of a very large staff of coolies to deal with the ground on an extensive scale; but in order to do this, it was necessary to buy up the rights of those natives who were already in possession of the desirable places.

According to a report by Professor J. W. Judd, C.B., the rubies of Burma are found "associated with garnet, spinel, and graphite in beds of coarse gravel, and embedded more or less in crystalline limestone, which exists alternating with gneissic and schistose rocks."

The ruby-bearing stratum, which is known locally as "byon," is situated from five to twenty feet from the surface, and it may be of any thickness, from a few inches to twelve feet or so. From ancient times it has been extracted by the native miners working under licence by merely digging pits in the valleys and cuttings of various depths in the hillside, whilst much is obtainable from the natural caves and caverns of the mountains.

The methods of the company are similar, except that the excavations are very much more extensive, because of the introduction of up-to-date means of hauling and pumping (see Figures 6 and 7).

The largest mine is about one thousand two hundred feet long, with an average width of five hundred and forty-nine feet and a depth of forty-five feet.

After the earth has been dug out it is loaded on to trucks, which are hauled to a screening apparatus, through which it falls into a washing machine (see Figure 10). This machine is armed with rows of steel teeth set in revolving arms, which churn the earth, now in the condition of thick mud, so that the clay and light gravel flow over into a pan, leaving the heavy gravel containing the rubies behind. The residue is then conveyed in trucks with locked covers to another piece of apparatus, consisting of screens of different grades of meshing, from which it falls into the pulsator (see Figures 8 and 9).

This machine still further divides the material into that which is useless and that containing the rubies. The former is tipped into trucks for removal, and the latter falls into a locked cabinet, to be afterwards sorted by the company's officers (see Figure 11).

This elaborate system of washing and sorting precludes the possibility of any ruby being lost



FIGURE 1. Hillside Workings.



FIGURE 2. Valley Workings by means of pits.

From Paintings by a Burmese Artist, kindly lent by Burma Ruby Mines, Limited.



FIGURE 3. A Native Miner.



FIGURE 4. A Native Worker.



FIGURE 6. A typical view of the Ruby-bearing area.



FIGURE 5. A view of Mogok, with the building where the Rubies are sorted and sold.



FIGURE 7. One of the Cuttings.

From Photographs by Mrs. M. L. Milne.

or overlooked. It has been found to be expedient to erect washing apparatus in whatever locality the digging is being carried on at the time, instead of hauling the byon from all directions, and for great distances, to a central plant.

The native miners who work on their own account have next to no apparatus, and their few mining implements are of the most simple and primitive kind; yet a great amount of successful work is done by their means. Figures 1 and 2, which accompany these paragraphs, are made from photographs of water-colour paintings by Burmese artists. They are interesting, not only on account of the quaint manner in which they are painted, but for the accuracy with which they depict the work upon which the figures are employed.

The queerly shaped gentleman with the tattooed legs is hammering in the corner-posts of a pit, and another man at the opposite side of the picture is bringing timber to shore up the walls of a pit. The figure in the right-hand corner is bringing tufts of grass to stuff into the crevices between the beams, and another is seen with a basket washing earth in the water. The long, swinging poles, with cords, and weighted with baskets of stones, are used as cranes, and are similar to those of the "gemming parties" of Ceylon, by means of which the earth is hoisted from the pits to the surface (see Figure 2).

A tool which is not, however, illustrated in the pictures consists of a huge wooden squirt, and is used to get rid of surplus water from the gem pits.

One of the pictures shows how the hillside streams are diverted, so that the water is caused to pour down on any vein of byon which may be exposed on the surface (see Figure 1).

The native miners, who are Burmans and Shans (see Figures 3 and 4), make a fairly good living by bartering the stones, and in this business they are not only shrewd, but very speculative. They purchase largely from the auction sales of the company, which take place every two weeks; and it is no uncommon occurrence for them to hazard a large sum on the chance of a stone of doubtful quality turning out to be of value. The officers of the company, however, make a rule of deprecating any tendency to gambling of this kind among the natives, as it eventually leads to dissatisfaction.

As the sales of the company take place in Mogok (see Figure 5), which has for centuries been a native market for the stones, this town may be considered the centre or chief market for rubies of the world, and it is visited by buyers from India, China, Europe, and America.

Within the last few years, however, a good deal of the trade has shifted from Mogok to Madras and Trichinopoli. The gems of choice quality which are found by the company are consigned to the London offices for disposal in Hatton Garden.

Owing to the extreme scarcity of important

rubies and the rarity of even moderately good ones, it has been found that the only way to make the gem-mining of Burma pay its way as a commercial concern is to secure and market a very large quantity of gems of medium quality and lower grades.

Some specimens of coloured corundum, when cut *en cabochon*, that is, with a smooth, convex surface, and at a certain angle of the crystal, display a six-pointed glimmering star of reflected light. No matter of what colour the stone may be, the shining rays which diverge from the centre of it are in all cases colourless, or nearly so.

These gems, which are known as "asteria," or, more popularly, as "star-stones," are, if of choice quality, highly esteemed on account of their rarity and beauty. The blue ones are also often called "star-sapphires" and the red "star-rubies," and the latter are found in Burma.

In company with the rubies are found a good many spinels—a mineral which may be any one of many colours, and which, when red, somewhat resembles the ruby, in which case it is often called "spinel-ruby"—and also some pale sapphires of little importance.

From most remote times the red spinels, or, as they are also called, "balas" rubies, have been to some extent confused with the true rubies, and they are catalogued as "balases" in the contemporary inventories of jewels of the early Middle Ages, and continue to be mentioned in similar ancient documents of the Renaissance period and later times.

A well-known instance of this is the list of Queen Elizabeth's jewellery.

The enormous red stone of irregular shape and convexity belonging to the regalia of Great Britain, and worn in the State Crown, which is known as the "Black Prince's Ruby," is, as a matter of fact, a balas ruby, or red spinel.

This "fair rubie, great like a rocket ball," was given to the Prince, from whom it takes its name, after the battle of Najara, by Petro, the cruel king of Castille, and it was worn in the helmet of Henry V at Agincourt. At some distant period it has been drilled entirely through the length of the stone, but the ends of the bore have, in more recent years, been plugged with small stones of the same colour as the large stone.

The spinel is one of the three jewel-stones occurring in the form of crystals, which are singly refractive, the other two being garnet and diamond.

The ancient system of issuing mining licences to the natives of Burma is still continued, the company being entitled, by agreement with the Government, to grant such privileges for payment, provided that a certain proportion of the fees thus obtained be handed over to the authorities.

The result of this arrangement is satisfactory, for, owing to there being plenty of space, the natives carry on their work successfully, without interfering with the enterprise of the company, which,

naturally, derives an income from the royalties.

Since the formation of the company the well-being of the native inhabitants has greatly improved, and the town of Mogok has become of greater importance.

The writer is indebted for information, the native pictures, and some of the photographs to the secretary of the Burma Ruby Mines, Limited, and for five of the photographs to Mrs. M. L. Milne, of Mogok.

SOLAR DISTURBANCES DURING NOVEMBER, 1914.

By FRANK C. DENNETT.

ONLY on one day, November 29th, was it found impossible to make solar observations, and on all but two (16th and 17th) of the other days of the month spots were visible, and faculae were present on those two, so that the Sun appears to have been never quite free from disturbance. The central meridian at noon on November 1st was $174^{\circ} 56'$.

As No. 36 of the October list remained visible until November 3rd, it reappears on the present chart.

No. 37.—First seen as a triangle of pores in a faculic cloud some two and a half days within the south-eastern limb on November 3rd, and little changed on the 4th. On the 5th they were nearly in a line, but traces of smaller ones were showing south of the eastern larger spotlet. On the 6th there was a spotlet around which clustered five pores, but next day there again appeared a line of pores forming two curves, whilst on the 8th, when last seen, there were only two pores ten thousand miles apart. The total length of the group was sixty-eight thousand miles.

No. 38.—This fine group was first seen on the 7th, lying diagonally in latitude. There were two larger spots, each some ten thousand miles in diameter, with pores between them, the length of the group being forty-nine thousand miles. The dark helium line D_3 was easily seen in the spectrum of the group-area. The two spots and their attendants receded from each other until, on the 12th, the disturbance was nearly one hundred thousand miles in length. On the 14th, when last seen, only one spot was visible, with attendant faculae, near the limb.

No. 39.—Two pores seen on the 13th, three the next day, and one on the 15th when last observed. The length was thirty thousand miles.

No. 40.—Only two pores seen on the 18th.

No. 41.—First seen as two spots in a faculic disturbance, just well round the limb, on the 18th, with a tongue-shaped prominence on the limb, round which they had come. The eastern spot was the larger on the 20th and 21st, with the inner edge of the penumbra brightest around its two umbrae. On the 24th there were pores in front of the spot, making the disturbance forty-eight thousand miles in length. It was last seen as a pore on the 27th. Its greatest diameter was eight thousand miles.

No. 41a.—A solitary spot first seen on the 21st, next day having a pore twenty-one thousand miles in its rear, and two on the 24th when last seen.

No. 42.—A pair of spots, the leader being largest, in a faculic area, just round the limb, on the 24th. On the 27th, when last seen, they were like two moderate pores, seventy thousand miles apart, with a minute point close in front of the eastern one.

No. 43.—A spot fifteen thousand miles in diameter close within the limb on the 27th. As it advanced across the disc it was seen to have a trail of pores and spotlets, one hundred and nineteen thousand miles in length, stretching diagonally from latitude 21° to 27° south. When last seen, on December 8th, it was apparently a single spot some 22° from the limb, with a long faculic trail covering the area of the pores and spots previously observed.

No. 44.—A spot first seen about two days within the limb on November 30th: evanescent pores showed round it. On December 1st and 2nd the umbra appeared double, but on the 3rd the larger umbra was itself delicately bridged and its northern portion red in colour. It was sixteen thousand miles in diameter. By the 5th its appearance had much changed, and more so on the 8th, when a spell of cloudy weather interrupted the observations.

Faculae were seen near the south-eastern limb on November 2nd, amid which No. 37 afterwards developed; on the 7th, two at longitude 37° , S. latitude 32° , and 43° , S. 27° ; and on the 27th. The faculic remains of No. 37 were also seen near the south-west on the 12th. A bright ridge at 64° , N. latitude 29° was seen on the 4th and 5th near the north-east limb; again on the 6th and 7th a knot around 34° , N. 30° ; from the 15th till 17th the great remains of No. 34 from 258° to 285° , N. 23° were observed; on the 20th, faculae marked the place where No. 41a afterwards appeared; and on the 22nd a double disturbance around 196° , N. 23° was seen. On the 17th that seen at 34° , N. 30° was again observed near the north-west limb; also the remains of Nos. 41 and 41a on the 28th and 30th.

The chart has been constructed from the combined observations of Mr. John McHarg and the writer. One of our usual helpers, Mr. J. C. Simpson, we deeply regret to say, died on November 28th at the age of seventy-six.

DAY OF NOVEMBER, 1914.

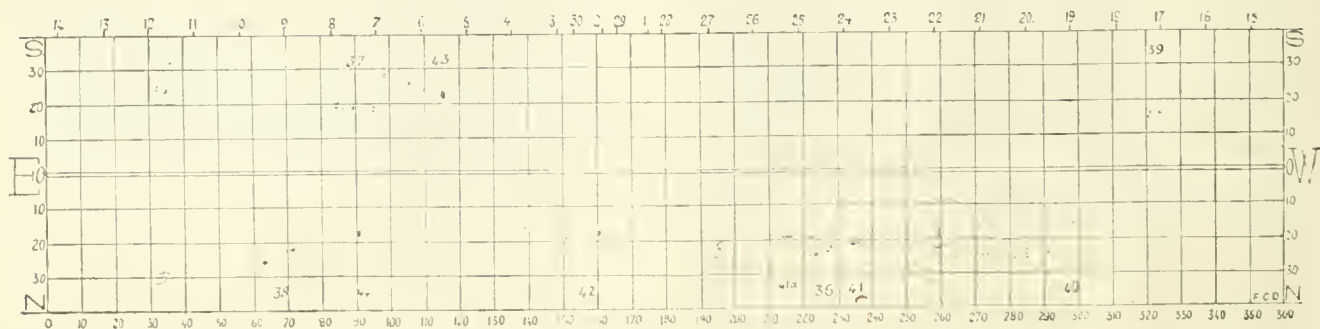




FIGURE 8. The Pulsator.



FIGURE 9. The trucks with locked covers. The contents of one are being tipped into the pulsator.

From photographs kindly lent by the Burma Ruby Mines, Limited.

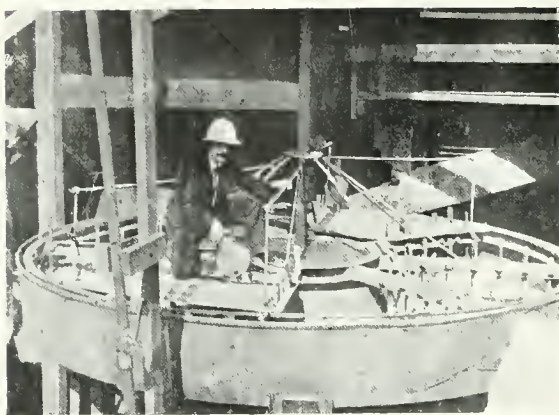


FIGURE 10. The Washing Machine.



FIGURE 11. One of the Sorters.

From photograph kindly lent by the Burma Ruby Mines, Limited.



FIGURE 12.

The "Edwardes Ruby" in the British Museum (Natural History).

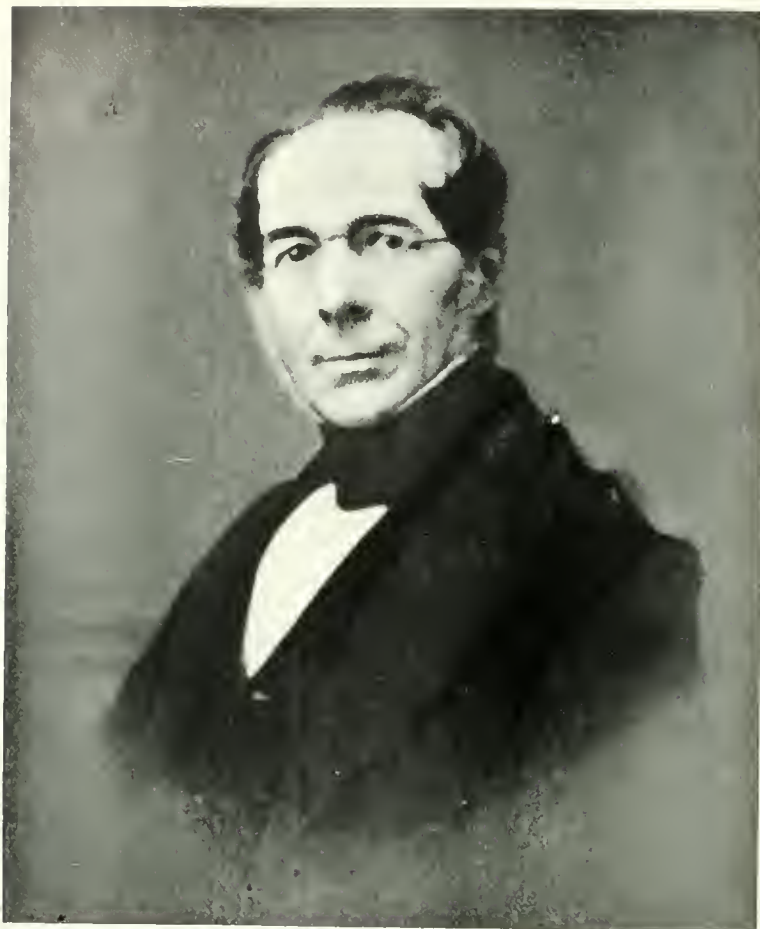


From a photograph by

FIGURE 13.

Mrs. M. L. Milne.

Natives valuing Rubies.



By the courtesy of

"The Observatory."

FIGURE 14. The Rev. William Rutter Dawes.

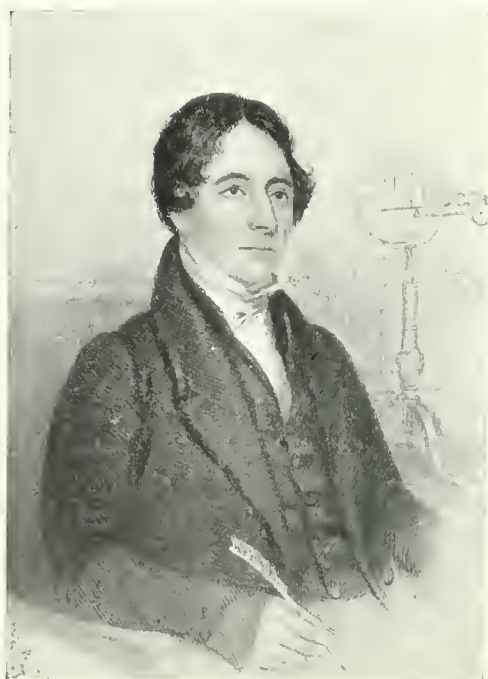


FIGURE 15. Thomas Dick, LL.D.



FIGURE 16. The Rev. T. W. Webb.

THE AMATEUR IN ASTRONOMY.

By W. F. DENNING, F.R.A.S.

It has been recently hinted that in view of modern developments the amateur is practically out of the field—or soon will be—in astronomical work and investigations. Present-day requirements are such that large instruments, elaborate apparatus, and refined researches, with perhaps spectroscopic and photographic agenda, are absolutely needed; and, often enough, the necessary studies are most laborious, requiring close application over a long period, and including critical mathematical analysis. These and other reasons may be suggested for the opinion that the amateur is losing ground, and will not take the prominent part he has done in the past in aiding the progress of astronomy.

Judging, however, from the facts and the teaching of recent years, such an opinion seems quite inconsistent with the real condition of things. There is no doubt whatever that amateur work will always be pretty much to the fore, and possibly rank in value with that of the best professional talent.

The field is wide enough for each to distinguish himself, the harvest of objects so extensive that every kind of student may reap a share. Much the same array of circumstances will continue as obtained a century ago—the professional and the amateur will work with increasing numbers and energy towards the goal of a more complete knowledge.

It must be remembered that many of our professional astronomers were amateurs at first, and showed such ability and proficiency that they were invited into the professional ranks. As

examples of this, there are Barnard, Burnham, and many others in America.

If the history of astronomy be consulted, the names of distinguished amateurs will be found in every succeeding generation, who have effected valuable work in astronomy. It is remarkable that they have achieved so much, considering the obstacles often impeding them, such as want of time, lack of means, and suitable training. There are greater numbers of the ordinary population than is generally supposed who occupy themselves in astronomy as a hobby, and those few among them who love the science sufficiently to pursue it in spite of the difficulties confronting them, and are impelled onwards by success, usually comprise men of real ability and aptitude for the work. They have naturally risen above the rank and file, and represent “the survival of the fittest.”

The amateur can do good work in nearly every department, but there are some which apparently suit his capabilities and inclinations in a special degree. These I need not mention, as they are sufficiently obvious to everyone acquainted with the subject. To amateurs of means of course there is hardly any limit to the extent of the valuable services they may render the science. Lord Rosse, James Nasmyth, Robert Carrington, William Lassell, and quite a host of others will be well remembered. The literary work of certain amateurs has also had a great influence: we may mention the books of Dick (see Figure 15), Proctor, Flammarion, Smyth, Chambers, J. F. W. Herschel, Agnes Clerk, Webb (see Figure 16), and others.

(To be continued.)

SOCIETIES.

THE LINNEAN SOCIETY.—At a meeting of the Linnean Society, held on Thursday, December 17th, 1914. Mr. Miller Christy, F.L.S., exhibited a remarkable gall, which he believed to be new to this country. It is in the nature of a “Witches’ Broom,” but appears on *Salix fragilis*; whereas no “broom” of the kind has hitherto been recorded on any species of willow in this country. It appears in great abundance on all trees of the species named growing in proximity. According to Professor Nalepa, it is due to a gall-mite, *Eriophyes triradiatus*, but not improbably a parasitic fungus may assist.

So far, the gall is confined apparently to a limited area within a radius of, say, twelve or fifteen miles around London. Mr. Christy has seen it or had it reported to him from Walthamstow, Chingford, Romford, Dagenham, and from Eltham and other places in Kent; and he has been unable to hear of it having been seen anywhere earlier than three or four years ago. It is unnoticed, he believed, in any work on the plant-galls of Britain.

The gall seems to appear only on *Salix fragilis*; never on *Salix alba* var. *caerulea*. This is fortunate, as the former is a tree of almost no economic importance, while the latter is of high value.

The gall is remarkable in that it appears on the female flower, which develops during summer, till it resembles a

bunch of moss, of an olivaceous green colour, from two to eight inches in length, hanging from a small twig. The bunch consists of hundreds, perhaps thousands, of abnormal flowerets.

In the course of the winter the gall or broom shrivels and becomes black, but continues to hang on the trees through the following summer, presenting a most striking appearance.

ROYAL INSTITUTION.—The following are among the lectures to be given at the Royal Institution before Easter: Professor William J. Pope, two lectures on Colour Photography—Scientific Applications: (1) “Photographic Appreciation of Colour in Monochrome”; (2) “Photography in Natural Colours.” Professor Sir James G. Frazer, two lectures on “The Belief in Immortality among the Polynesians.” Dr. Henry G. Plimmer, three lectures on Modern Theories and Methods in Medicine. Dr. Chalmers Mitchell, three lectures on Zoological Studies—War and Evolution: (1) “Nations as Species”; (2) “Struggle of Species”; (3) “Struggle of Nations.” Professor Sir J. J. Thomson, six lectures on “Recent Researches on Atoms and Ions.” The Friday evening meetings will commence on January 22nd, when Professor Sir James Dewar will deliver a discourse on “Problems of Hydrogen and the Rare Gases.”

FLORA SELBORNENSIS.

THE page of Gilbert White's "Calendar of Flora" which we give this month is the first, and it is concerned to a considerable extent with the weather.

JANUARY, FIRST MONTH.

25th.—The Bat mentioned is most probably the Pipistrelle (*Vesperugo pipistrellus*).

FEBRUARY, SECOND MONTH.

1st.—For the Great Titmouse, Gilbert White uses the name *Parus major*, by which it is still known.

CORRESPONDENCE.

ANTISEPTIC CLOTHING.

To the Editors of "KNOWLEDGE."

SIRS,—We owe to Sir William Perkin the discovery of constructing artificial dyes from products of coal-tar. The discovery proved to be of importance, not only in dyeing cloth, but, of still greater importance, in staining microbes, making them visible and distinguishable.

This discovery led to the theory of "side-chains" in the microbes, and, further, the construction of that chemical compound called "Salvarsan," which is so deadly to one particular variety of spirilla.

It has been noted that in the war, whenever serge from the clothing was carried in with the shell fragment, the wound was more septic than when pieces of linen were carried. It may be that, the former being more spongy in character than the latter, the bacteria of putrefaction perhaps find a more suitable substance to lodge in and multiply in serge than in linen, being a little more compact.

Is it not possible for some men of science, especially biochemists, to find out a process by which wool or woollen fabrics can be made, not only aseptic, but thoroughly antiseptic, so that the microbes may not find in them a suitable place to lodge in and multiply? It will be as much a prophylaxis to the material worn as inoculation for enteric and cholera is to a soldier.

P. J. DAMANIA.

WORTHING.

LETCHWORTH MUSEUM.

To the Editors of "KNOWLEDGE."

SIRS,—May I be allowed, through your valuable medium, to make known to readers of your paper that a local and educational museum has recently been opened at Letchworth, which it is intended shall, in course of time, be representative of the geology, fauna, flora, and human history of North Hertfordshire and a twelve-mile radius of Letchworth, thus embracing South Bedfordshire and a small part of South Cambridgeshire?

The museum owes its inception to the late Miss James, of Haslemere, and the generosity and goodwill of Mr. Aneurin Williams, M.P., Chairman of First Garden City, Limited. It is under the management of the Garden City Naturalists' Society. Donations towards the upkeep and the necessary expenditure which a museum entails will be gratefully received.

It is hoped that the publication of this letter will result in an increased membership and an influx of visitors. Gifts or loans of objects of interest from the localities mentioned will be most acceptable, as will also books devoted to natural science, local industries, and topography.

I shall be pleased to forward further particulars to anyone interested, or to arrange for visitors to see the collections of local and educational objects at present exhibited.

W. PERCIVAL WESTELL, F.L.S.

LETCHWORTH.

TO OBTAIN THE COLOURING MATTERS OF RED ALGAE.

By W. B. GROVE, M.A.

It is not always easy to extract in the best condition the Chlorophyll and Phycoerythrin which are contained in Red Seaweeds. For that reason a description of the following processes, which are very successful, may be useful to some who have not previously been satisfied. In order to make the account complete, certain steps which are obvious enough are included in the description. The two coloured solutions thus obtained appear very pure in tint, and, so far as such different colours can be compared, they are of approximately the same intensity.

The Alga which has been found to serve best is *Rhodomenia palmata*, one of the abundant Dulse of our coast. The quantity which can be packed in a one-pound cocoatin is sufficient for the purpose: it should be sent from the sea freshly gathered, and on the morning of arrival should be divided into two equal portions, for separate treatment. A longer delay will produce inferior results.

Place one portion in a saucepan or beaker, with plenty of water, and bring to the boil; continue the boiling for five to ten minutes, or even longer. Then rinse quickly in two lots of "industrial" spirit; pack lightly in a suitable vessel, just cover with fresh spirit, and leave in the dark for twenty-four to forty-eight hours. On pouring off the solution, it will be found to be of a deep, rich, and beautiful chlorophyll-green, with blood-purple fluorescence—as good a colour as is generally to be obtained from grass-leaves.

The other portion of the Alga should be washed repeatedly (ten or more times) in tepid water, until the water, after use, looks as pure as before. Then carefully remove all the bases

and stalks of the fronds, and every diseased and discoloured part, or those which are occupied by zoöphytes, and so on. This can best be done with a pair of scissors. The selected clean and bright-coloured laminae are then cut up with the scissors into pieces about five to ten millimetres square, or less. These should be packed as tightly as possible in a tall glass vessel, about one and a half to two inches wide. It is convenient to place the pieces round a glass rod standing in the centre of the vessel, and ram them down with a suitable wooden stick.

Then withdraw the rod, just cover the pieces with distilled water, see that it penetrates into every part (which does not always happen if they are tightly packed), pour on the surface four or five drops, or more, of eucalyptus oil, according to the size of the vessel, as a disinfectant, and leave in a shaded place for four days at room temperature.

The solution may then be poured off, and should be perfectly clear; if not, it may be filtered in the ordinary way. It is of a very deep rose-pink colour, showing a remarkably strong and beautiful orange fluorescence, so that by reflected light it appears to be filled with a multitude of minute orange glistening particles. If more distilled water is afterwards placed in the vessel, a second but weaker solution can be obtained in another four days.

Both the green and the pink solutions will keep for a considerable time—even for more than a month—in the dark. Other seaweeds, *Chondrus*, *Dilsea*, *Polysiphonia*, *Ceramium*, and so on, have been tried, but in all cases the results were inferior.

1.

The Calendar of Flora.

1st Month.

Jan: 1st The year begins with a remarkable dry frost.

13. Severe still frost yet: the roads very dusty.

25. A gentle thaw.

The bat (*Vespertilio*) appears.

Hepaticas in bloom all the frost.

Wall-flower (*Leucojum*) in bloom.

Laurustine 2^d Month. blows.

Feb: 1. Thaw. Wind & rain: none for many weeks.

The ^{great} Titmouse (*Parus* ^{major}) begins his spring note.

Moles work much.

Robins assemble on their nest-trees. 3rd Severe frost.

13: 14: 15. Continued rains that occasioned vast floods in some parts: in some parts the fall was a very deep snow: in others a freezing rain which broke & defaced multitudes of trees.

22. On my return from London I found the Snow-drop, & winter aconite in bloom; & the Crocus blowing; the Hazel, *corylus sylvestris*,

THE FACE OF THE SKY FOR FEBRUARY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 1.

Date.	Sun.		Moon.		Mercury.		Venus.		Saturn.		Neptune.	
	R.A.	Dec.	R.A.	Dec.	R.A.	Dec.	R.A.	Dec.	R.A.	Dec.	R.A.	Dec.
Greenwich Noon.	h. m.		h. m.		h. m.		h. m.		h. m.		h. m.	
Feb. 5	21 12'3	S. 16'2	13 18'6	S. 13'1	22 22'4	S. 6'8	17 55'0	S. 19'8	5 41'7	N. 22'4	8 2'6	N. 20'1
" 10	21 32'3	14 6	18 17'3	S. 27'6	22 34'9	7'1	18 16'7	20'1	5 41'0	22'4	8 2'1	20'1
" 15	21 52'0	12'0	22 50'0	S. 5'9	22 32'2	6'0	18 39'0	20'2	5 40'4	22'4	8 1'6	20'1
" 20	22 11'4	11'2	2 36'1	N. 20'7	22 16'0	6'8	19 1'8	20'1	5 40'1	22'4	8 1'1	20'2
" 25	22 30'4	S. 9'4	7 8'0	N. 26'4	21 56'0	S. 8'9	19 24'9	S. 19'8	5 40'0	N. 22'4	8 0'6	N. 20'2

TABLE 2.

Date.	Greenwich Noon.			Midnight Moon.
	P	Sun. E	L	
Feb. 5	- 13'7	-6'3	350'2	+20'3
" 10	- 15'6	6'6	284'4	- 3'8
" 15	- 17'4	6'9	218'5	-21'5
" 20	- 19'0	7'0	152'7	-16'2
" 25	- 20'5	-7'2	86'8	+ 7'3

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc.

For the future the data for the Moon and Planets in the Second Table will be given for Greenwich Midnight, *i.e.*, the Midnight at the end of the given day.

The letters *m*, *e* stand for morning, evening. The day is taken as beginning at midnight.

THE SUN is moving Northwards more rapidly. Its semi-diameter diminishes from 16' 16" to 16' 10". Sunrise changes from 7^h 43^m to 6^h 50^m; sunset from 4^h 45^m to 5^h 36^m.

ANNULAR ECLIPSE OF THE SUN ON FEB. 14TH.—The central line crosses West Australia and New Guinea. The following points lie on it; 114° 14' E., 29° 17' S.; 124° 43' E., 20° 2' S.; 132° 3' E., 12° 11' S.; 141° 24' E., 3° 8' S. Partial eclipse is visible throughout Australia, Tasmania, Malay Archipelago, and Madagascar.

MERCURY is an evening star till the 20th. 33' North of Jupiter on 2nd. Semi-diameter increases from 3" to 5". Illumination diminishes from $\frac{3}{4}$ to zero, and then rises to $\frac{1}{10}$.

VENUS is a morning star, at Greatest Elongation, 47° W., on 6th. Illumination increases from $\frac{1}{2}$ to $\frac{3}{4}$. Semi-diameter diminishes from 13" to 10".

THE MOON. — Last quarter 7^d 5^h 11^m *m*. New 14^d 4^h 31^m *m*. First quarter 22^d 2^h 58^m *m*. Perigee 7^d 1^h *e*. Apogee 21^d 6^h *m*, semi-diameter 16' 10", 14' 48" respectively. Maximum librations 7^d 7° N., 14^d 5° W., 21^d 7° S., 27^d 6° E. The letters indicate the region of the Moon's limb brought into view by libration. E., W. are with reference to our sky, not as they would appear to an observer on the Moon (see Table 4).

MARS is invisible, in conjunction with Sun Dec. 24th.

JUPITER is in conjunction with the Sun on 24th, and is therefore practically invisible this month.

SATURN is between Taurus and Gemini. In perihelion on 21st. Stationary on 26th. Polar semi-diameter 9". Major axis of ring 44", minor 20". Angle P—5°·7.

Eastern elongations of Tethys (every 4th given) 1^d 2^h·8 *m*, 8^d 4^h·0 *e*, 16^d 5^h·2 *m*, 23^d 6^h·4 *e*; of Dione (every 3rd given) 3^d 1^h·9 *e*, 11^d 6^h·9 *e*, 19^d midnight, 28^d 5^h·1 *m*; of Rhea (every 2nd given) 8^d 8^h·5 *m*, 17^d 9^h·3 *m*, 26^d 10^h·2 *m*.

For Titan and Japetus E., W. stand for East and West elongations, I. for Inferior (North) conjunction, S. for Superior (South) conjunction. Titan 4^d 0^h·1 *e* E., 8^d 11^h·7 *m* I.,

TABLE 3. LONG-PERIOD VARIABLE STARS.

Star.	Right Ascension.			Declination.	Magnitudes.	Period.	Date of Maximum.
	h.	m.	s.				
U Cassiopeiae	0	41	35	+47 38	7·7 to 13·5	278	1915—Feb. 11
S Cassiopeiae	1	13	22	+72 10	7·2 to 13·7	610	" Jan. 31
Mira Ceti	2	15	3	- 3 21	2·0 to 9·6	331	" Feb. 11
R Ceti	2	21	42	- 0 34	7·5 to 12·8	167	" Mar. 6
U Arietis	3	6	20	+14 28	7·0 to 9·2	370	" Feb. 17
X Camelopardi	4	34	29	+74 58	7·5 to 13·5	141	" Jan. 13
R Lyncis	6	54	18	+55 27	6·5 to 14·0	379	" Apr. 10

Special attention should be given to Mira Ceti, which will reach its Maximum in February. It must be observed as early in the evening as possible.

Night Minima of Algal 1^d 3^h·0 *m*, 3^d 11^h·8 *e*, 6^d 8^h·6 *e*, 9^d 5^h·4 *e*, 21^d 4^h·7 *m*, 24^d 1^h·5 *m*, 26^d 10^h·3 *e*.
Period 2^d 20^h 48^m·9.

Principal Minima of β Lyrae February 3^d 10^h *e*, 16^d 8^h *e*. Period 12^d 21^h 47^m·5.

12^d 8^h·7 *m* W., 16^d 8^h·1 *m* S., 20^d 10^h·3 *m* E., 24^d 10^h·1 *m* I., 28^d 7^h·2 *m* W.; Japetus 9^d midnight l.

URANUS is invisible. In conjunction with Sun February 1st.

NEPTUNE was in opposition January 20th, diameter 2".

DOUBLE STARS AND CLUSTERS.—The tables of these, given three years ago, are again available, and readers are referred to the corresponding month of three years ago.

VARIABLE STARS.—Stars reaching their maxima in or near January, 1915, are included. The lists in recent months may also be consulted. (See Table 3.)

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant.		Remarks.
	R.A.	Dec.	
Feb. 5-10 ...	75°	+ 41°	Slow, bright.
" 15 ..	236°	+ 11°	Swift, streaks.
" 15 ..	261°	+ 4°	Swift, streaks.
" 19-28 ..	155°	+ 14°	Slow.
" 20 ...	263°	+ 36°	Swift, streaks.

TABLE 4. Occultations of Stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance.		Reappearance.	
			Time.	Angle from N. to E.	Time.	Angle from N. to E.
1915.			h. m.	°	h. m.	°
Feb. 1 ..	WZC 688	7·0	—	—	8 16 <i>e</i>	261
" 1 ..	44 Leonis	5·9	8 46 <i>e</i>	113	9 51 <i>e</i>	304
" 2 ...	48 Leonis	5·2	3 28 <i>m</i>	169	4 18 <i>m</i>	262
" 2 ...	BD + 3°·2475	6·9	—	—	9 31 <i>e</i>	248
" 2 ...	75 Leonis	5·4	10 18 <i>e</i>	121	11 24 <i>e</i>	305
" 2 ...	76 Leonis	6·0	11 26 <i>e</i>	139	0 33 <i>m</i> *	291
" 4 ...	BAC 4119	6·6	3 1 <i>m</i>	91	3 59 <i>m</i>	343
" 6 ...	BD - 16°·3760	7·0	—	—	1 5 <i>m</i>	354
" 8 ...	4 Scorpii	5·6	—	—	3 25 <i>m</i>	348
" 9 ...	WZC 1098	6·7	—	—	6 28 <i>m</i>	315
" 10 ...	BAC 6127	4·7	—	—	5 49 <i>m</i>	347
" 15 ...	BD - 5°·5917	7·0	5 33 <i>e</i>	79	—	—
" 16 ...	21 Piscium	5·8	5 56 <i>e</i>	132	6 15 <i>e</i>	168
" 21 ...	18 Tauri	5·6	7 7 <i>e</i>	88	8 26 <i>e</i>	249
" 22 ...	BD + 26°·731	7·0	7 30 <i>e</i>	81	—	—
" 23 ...	BAC 1746	6·5	9 13 <i>e</i>	89	10 27 <i>e</i>	284
" 24 ...	BD + 27°·1122	7·0	7 38 <i>e</i>	113	—	—
" 25 ...	A Geminorum	5·1	6 54 <i>e</i>	99	8 14 <i>e</i>	287
" 27 ...	WZC 582	6·6	4 49 <i>m</i>	148	—	—
" 27 ...	WZC 626	7·3	5 50 <i>e</i>	56	—	—
" 28 ...	BD + 15°·2027	6·5	2 5 <i>m</i>	201	2 16 <i>m</i>	221

*The asterisk indicates the day following that given in the date column.

From New to Full disappearances take place at the Dark Limb, from Full to New reappearances.

Attention is called to the tangential occultations of 21 Piscium and BD+15°·2027.

Probably for some points in England these stars will escape occultation.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

PROFESSOR E. W. BROWN ON THE MOON'S MOTION.—Professor Brown was Chairman of the Cosmical Physics Section at the recent meeting of the British Association. *Nature* for October 15th contains his address, which brings out the fact that the study of the Moon's motion has now reached a point where it overlaps with the study of the physics of the solar system, forces of electrical or magnetic character being invoked as possibly responsible for the residuals that still remain in the observed places of the Moon.

The growth of human knowledge on this subject forms a long and glorious chapter of difficulties patiently surmounted. As far back as the time of Hipparchus we find a knowledge of the eccentricity of the orbit and of the change in the direction of the major axis, which revolves in about nine years. The Evection, the largest of the disturbances produced by the Sun, was discovered by Ptolemy; the Variation, the next in order of magnitude, seems to have been found by the Arabian, Aboul Wefa,

about A.D. 975: it was rediscovered by Tycho Brahé. The ancient astronomers also knew of the inclination of the Moon's orbit to the ecliptic, and the retrograde motion of the line of nodes. They could predict eclipses by the Saros cycle, but could not predict the region where an eclipse would be total. So far, all the discoveries had been of a purely empirical nature; no explanation could be given of the cause of the various irregularities. That was reserved for Newton, who applied the question as a searching test of his law of gravitation. His wonderful mathematical powers enabled him to explain the larger lunar irregularities by geometrical methods; these, however, proved inadequate for such intricate problems, and Newton laid the foundations of the calculus and of analytical methods, which were further developed by Clairaut, d'Alembert, and Euler, followed a century later by Hansen and Delaunay, and, still more recently, by Newcomb and Professor Brown himself, who, following up a suggestion of the late Dr. Hill, has made a new computation of the gravitational effect of every known body in the solar system on the Moon's motion to a degree of accuracy beyond that which observation can at present attain. In spite of this notable advance in accuracy, no such illusions are entertained about the new tables as were put forward

by Sir J. Herschel on the appearance of Hansen's tables some sixty years ago. In giving the Gold Medal of the Royal Astronomical Society to Professor Hansen, he said his results "might be considered as a practical completion of the lunar theory, at least for the present astronomical age, and as establishing the entire dominion of the Newtonian theory over that refractory satellite."

Not many years had passed before the tables began to show errors that developed at an alarmingly rapid rate. Newcomb made an exhaustive search for the cause, which involved a ransacking of old astronomical libraries to find observations of occultations and eclipses. He was able in this way to trace back the place of the Moon a century further than Hansen had done; he found that a Venus term, inserted by Hansen, ought not to be there at all, being really quite insensible. He removed this, and also altered the rate of the Moon's motion, as well as reducing the acceleration in a century from $12''$ to $8''$. He found that there was still a large wave in the motion, with a period of about two hundred and seventy years, and amplitude about $13''$. Vain attempts were made to explain this term gravitationally; it is now conclusively established that it cannot arise from the action of any known matter in the solar system, so that it is probably non-gravitational. A similar wave has recently been found with a period of about sixty-five years.

It need hardly be said that the value of Professor Brown's researches and new tables is in no way diminished by the fact that we cannot expect the Moon to move in strict conformity with them. It is a great point to know that the tables correctly represent the action of all known forces, and that any departure from them indicates either some unknown body, or some force other than gravitation. While Professor Brown feels some natural disappointment that his twenty years' devotion to this great problem has not completely unravelled all the mysteries of the Moon's movements, he has taken a long step forward, and has separated what is understood from what is mysterious. He has the consolation that problems that await a final solution are far more interesting than those completely solved. Professor Brown gives a diagram showing that there are unexplained fluctuations in the motion of the Sun and Mercury in the same direction, though smaller in amount than those in the Moon. He says: "We must look for some kind of a surge, spreading through the solar system, and affecting planets and satellites the same way, but to different degrees."

As an illustration of the extreme difficulty of predicting the place of the Moon with accuracy, even for a few years in advance, a comparison has been made of the new French tables (based on Delaunay) with the observations made at Greenwich this year. The observed R.A. is greater than the predicted by $0^s.20$, that is, $3''$ in arc. This is only a quarter of the error of *The Nautical Almanac*, but still it is unexpectedly large, considering that the new tables made use of recent observations, and introduced two empirical terms in the endeavour to represent the observations.

Professor Brown notes that the lunar methods give $1/294$ for the Earth's compression, while pendulum methods give $1/297$. He suggests photographic observations of the Moon at new stations to settle the question. Such observations, made at several points on the Equator, should also decide whether it [the Equator] is a circle or an ellipse with its axes differing by a mile or two.

Professor Brown adds some interesting information on the progress of the construction and printing of his tables. There are over one thousand terms in his expressions for the longitude, latitude, and parallax, but, owing to the care taken in combining as many terms as possible into a single table, the actual computation of a position will take very little longer than with Hansen's tables, which included only three hundred terms. The new tables will be used for the first time in *The Nautical Almanac* for 1919, as the places there have to be computed several years in advance, and 1918 is already computed.

FUTURE TOTAL ECLIPSES.—O. M. Mitchell's "Orbs of Heaven" has the following fine passage on the wonderful power which the knowledge of gravitation gives to the mind of the astronomer: "With resistless energy it rolls back the tide of time, and lives in the configuration of rolling worlds a thousand years ago; or, more wonderful, it sweeps away the dark curtain from the future, and beholds those celestial scenes which shall greet the vision of generations when a thousand years shall have rolled away, breaking their noiseless waves on the dim shores of eternity."

Oppolzer's "Canon of Eclipses" is a good instance of such calculations. It contains the details of all eclipses from the year -1207 to $+2161$, and has proved of vast service to students of chronology. The research was pushed further into the future by Rev. S. J. Johnson in "Eclipses Past and Future." He carried the examination of eclipses visible in Great Britain to the year 2491. A still greater extension has been published in the last few months by O. Schrader, who gives full particulars of all eclipses that are large in Central Europe from 2166 to 3045. It is now possible to form a trustworthy list of the totalities in the British Isles for the next eleven hundred and fifty years. I think it may be guaranteed that no eclipses are omitted from Table 5 that could possibly be total in our islands—at least as far as the year 2290. Beyond that point it may not be quite exhaustive, but all the favourable eclipses are included. I give enough data to draw the tracks on a map. The altitude of the Sun can be estimated from the time of day. The duration of totality is given, but where this is given as an exact number of minutes it must be taken as approximate only.

This makes twenty-six totalities in one thousand one hundred and fifty years, but two or three of them may not quite reach our shores. Mr. Maguire (*Monthly Notices of R.A.S.*, Volume XLV, page 400) gives a similar list of totalities for the past thousand years. He makes the number thirteen. Probably one should be added, namely, 968, December 22nd (Johnson). The barren interval of two hundred and three years from 1724 to 1927 is much the longest in the whole two thousand two hundred years; the next longest is one hundred and forty-five years (1185 to 1330). The average interval between British totalities is about fifty-five years. In the twenty-second century there are at least six, possibly seven, British totalities in a period of sixty-seven years. Edinburgh is highly favoured, having had five totalities in the last one thousand years, and with at least four in the coming period. London had none between 878 and 1715. It will possibly have totality in 2151, 2600, 2864; but in each case it will be a good way from the central line, according to the tables used.

I made a rough calculation some years ago that any given spot has totality about three times in one thousand years, or seven times in two thousand two hundred years. This is fairly borne out by these figures, Edinburgh having distinctly more than its share, London distinctly less.

It is interesting to note that in 3045 perihelion, which now happens about January 2nd, will have changed to January 21st. The obliquity of the ecliptic, now $23^{\circ} 27'$, will have diminished to $23^{\circ} 18'$.

The author calls attention to the curious partiality for Wednesday in the mid-European totalities of the next twelve hundred years. The fact that the 300-year cycle and the 521-year cycle are both exact numbers of weeks partly accounts for particular weekdays being favoured. The table affords many instances of these cycles: thus there are European totalities in 1842, 2142, 2442; in 1927, 2227; in 1945, 2245, 2545; in 2081, 2381, 2681 (all total in our islands); in 2126, 2426, 2726, 3026; and so on. The 521-year cycle gives European totalities in 1860, 2381, 2902, and so on. The triple Saros is well illustrated by 2081, 2135, 2189 (all total in our islands). The 521-year cycle brings back the latitude of eclipse tracks with great accuracy; but there is often a considerable shift in longitude, also in the diameter of the Moon, so that a total eclipse may be succeeded by an annular. It will probably surprise

many to see that totality in our latitudes can be as long as 5m 45s. There are several other totalities in Schrader's table falling but little short of this. Mr. Maguire gives 4m 55s for the duration of the eclipse of 885, June 15th, in Scotland. The shadow covered almost the whole of Scotland on that occasion.

Two eclipses of the next decade deserve a note. That of 1921, April 8th, is annular in Lewis, North-west Scotland,

and Shetlands (it is five hundred and twenty-one years before the total eclipse of 2442). Our last annular eclipses were in 1836, 1847, 1858.

The eclipse of 1925, January 24th, is total a few miles west of St. Kilda, but the Sun will be very low.

The year 1917 is interesting from having seven eclipses, the maximum possible number. This has not happened since 1805. It will happen again, after the Saros, in 1935.

TABLE 5.

Date and Hour.					Central Line.	Duration of totality on Central Line.
	d	h	m			m s
1927 ... June 29 ...	5	30	m	St. David's Head, Chester, Ripon	0	21
1954 ... June 30 ...	0	30	e	Just north of Shetlands, South Norway	1	30
1999 ... Aug. 11 ...	9	45	m	Southern Cornwall to Havre	2	0
2081 ... Sept. 3 ...	7	20	m	1° S. of Lizard to Jersey. (Probably total at Lizard) ...	3	0
2090 ... Sept. 23 ...	5	30	e	2° S. of Lizard to Paris. (Probably total at Lizard) ...	2	0
2133 ... June 3 ...	8	48	m	West coast of Lewis, just west of Shetlands	2	0
2135 ... Oct. 7 ...	7	30	m	Isle of Mull to North Berwick	3	0
2142 ... May 25 ...	8	45	m	Etaples to St. Omer. (May be total at Dover)	2	0
2151 ... June 14 ...	6	15	e	Belfast, Isle of Man, Manchester, Cambridge	2	30
2160 ... June 4 ...	5	30	e	Mizen Head, south-west of Land's End	2	0
2189 ... Nov. 8 ...	8	20	m	Dingle Bay, just west of Land's End. (Total at Land's End)	3	0
2200 ... April 14 ...	5	0	e	Donegal, Belfast, Mull of Galloway, Hartlepool	0	36
2290 ... June 7 ...	5	0	m	Graze west coast of Lewis and Shetlands	1	0
2381 ... July 22 ...	10	0	m	Islay, Ardrossan, Rothbury. Wide Track. (Total at Glasgow and Edinburgh)	5	0
2426 ... Sept. 2 ...	8	8	m	Malin Head, Ayr, Morpeth. Wide track. (Total at Glasgow and Edinburgh)	4	0
2442 ... April 11 ...	9	20	m	Limerick, Drogheda, Edinburgh. (Total at Dublin and Glasgow)	1	45
2545 ... April 12 ...	5	24	e	Bideford, Portsmouth, Boulogne	0	20
2600 ... May 5 ...	6	0	m	Cherbourg, Beachy Head, Thanet	2	45
2681 ... June 8 ...	1	40	e	Total both Orkneys and Shetlands	4	30
2726 ... July 21 ...	11	0	m	Brest, Paris, Lunéville. (Total in Channel Islands.) This is maximum duration for a European totality	5	45
2817 ... Sept. 2 ...	4	20	e	Mayo, Wexford, Pembroke, Poole	1	0
2864 ... Feb. 28 ...	1	0	e	Exeter, Oxford, King's Lynn	3	0
2911 ... Aug. 15 ...	2	20	e	Middle of Shetlands to Denmark	3	10
2927 ... Mar. 24 ...	1	50	e	Middle of Skye to Tain	3	6
2972 ... May 4 ...	3	0	e	Rum to Aberdeen	4	30
2974 ... Sept. 7 ...	0	5	e	Forty miles north-east of Shetlands to Hamburg. (Probably total in Shetlands)	4	0

TRANSIT OF MERCURY AND OCCULTATION OF PLEIADES.—Fine weather favoured both these phenomena at Greenwich. It was possible to deduce the times of contact in the former within two or three seconds from the combined observations. Individual observers differed more, some obviously timing apparent contact, others the snapping or forming of the ligament or black drop. Numerous measures of the diameter in various directions were made during transit. The observers agreed in making the east and west diameter about $\frac{1}{2}$ " smaller than those inclined at 45° on either side of it. It is difficult to accept this as a physical reality, but it is supported by measures at several other observatories, and by M. Jonkhoeve's measures at Lille in the transit of 1907. It will be necessary to wait a long time for further observations (at least in this country), as the transits of 1924 and 1927 will both end about an hour after sunrise, and definition is bad at such small altitudes.

More occultations were observed on December 1st than in the whole year preceding. The Moon was so near full that the stars disappeared very near the bright portion, but in the case of the bright stars this was no hindrance to accurate observation. Amateur observers will find occultations very pleasing observations to make: they take place with dramatic suddenness, and help one to realise the rapid march of the Moon across the star-vault. Further, if one can obtain accurate time, the observation and publication of the time of the phenomenon are of real service to science.

BOTANY.

By PROFESSOR F. CAVERS, D.Sc., F.L.S.

CONSTITUTION OF CHLOROPHYLL.—Recent work has shown that the familiar green pigment chlorophyll is a very complex substance, and has given rise to a considerable amount of controversy among plant physiologists and biochemists. In a recent paper Stoklasa, in collaboration with Sebar and Senft (*Beih. bot. Centralbl.*, Volume XXX), maintains his view that phosphorus is an essential element in chlorophyll, and finds that it becomes insoluble in alcohol or ether if dried leaves are used: this he regards as explaining the statement of Willstätter and others that phosphorus is not essential to chlorophyll. The chemical constitution of chlorophyll extracts from various plants is described: phosphorus is present in proportions of from 0.14 to 1.54 per cent. of the dry weight of the chlorophyll extract. Stoklasa considers that chlorophyll is made up of three different kinds of complexes: (1) Phaeophorb and metal groups soluble in alcohol and ether; (2) phaeophytin soluble in petrol ether; and (3) chlorolecithins, which are unions of either of these with phosphoglycerides. Magnesium is one of the metals, and it accompanies phosphorus. The colour-change of leaves in autumn is regarded as a breaking up of chlorophyll with separation of phaeophytin and phosphatides, which are brown in colour, and allow the yellow and red of xanthophyll and carotin to appear; the lecithins are not combined, but are mixed with the chlorophyll. The results of culture experiments show that both phosphorus and magnesium are necessary elements for the formation of chlorophyll, as well as for the growth of plants generally, though only in very small proportions.

A NEW GRAFT HYBRID.—An account—the first, we believe, that appeared in a British journal—of the work of Baur and Winkler on graft hybrids and chimaeras, the nature of which was discovered—or, perhaps more correctly, rediscovered—and worked out in detail by these authors appeared in "KNOWLEDGE" some time ago (Volume XXXIV, page 136). Bois (*Rev. Hort.*, 1914) has recently given an account of a mixed hybrid, somewhat on the lines of *Cytisus adami*, which resulted from the grafting of a pear upon a quince. The result of the grafting was the formation below the graft junction of two opposite branches, one of which showed quince characters, and the other those of a form which the author names *Pyrocydonia winkleri*,

differing markedly from both pear and quince. The new form, moreover, could be propagated truly, which is not the case with other mixed hybrids obtained in this way.

POLLINATION OF HERB ROBERT.—That even the commonest of plants will repay careful investigation is illustrated by the interesting study of the pollination in Herb Robert (*Geranium robertianum*) recently published by Stäger (*Beih. bot. Centralbl.*, Volume XXX). His observations harmonise the contradictory statements concerning the biology of this flower made by different writers; for he finds that it varies between a "fair-weather" type and a "bad-weather" type. In fair weather the anthers shed their pollen rapidly, and may finish doing so before the stigmas are ready for receiving pollen, flowering taking only half a day. In wet or cold weather, or in wet, cold places even in fine weather, the stigmas develop more rapidly than the anthers, and may take as long as three days to mature. Among other interesting observations, the author shows how colour, size, and the opening and closing of the flower are affected by light, though the chief factors concerned are temperature and the humidity of the air; for instance, high temperature and dry air hasten the opening of the anthers, while low temperature and damp air delay their opening and favour the growth of the stigma. Hence, according to external conditions, the flower may be either protandrous (anthers ripening first) or protogynous (stigmas ripening first), and in both cases self-pollination may eventually take place.

PROTHALLUS OF EQUISETUM.—The prothallus of *Equisetum* has often been described, so far as the common European and American species are concerned, as a creeping body bearing irregular leaf-like lobes, some prothalli being smaller and male, others larger and female. Kashyap (*Annals of Botany*, Volume XXVIII) has now described for the first time the prothallus of an Asiatic species, *E. debile*, which proves to be of great interest. It is very variable in its early stages, but frequently there is present a "primary tubercle" similar to that found in the prothallus of some species of *Lycopodium*. The lobes are always erect, and very close together, both in nature and in a darkened room; hence this position holds no relation to the amount of light. One of the striking features of the prothallus is its radial structure. Hitherto a sharp distinction has been drawn between the prothallus of *Lycopodium* and that of *Equisetum*, the former being radial and the latter flattened (dorsiventral). Hitherto also the prothalli of *Equisetum* have been generally described as dioecious, the small prothalli being male (with antheridia) and the larger ones female (with archegonia), though the spores are all alike in size; but in *E. debile* there are no male prothalli, though sometimes a prothallus produces no antheridia, and is therefore female. The sexual organs (antheridia and archegonia) of *E. debile*, again, show resemblances to those of *Lycopodium*, and the author lays stress upon the general affinity of this *Equisetum* prothallus to that of *Lycopodium cernuum*, remarking that there is no more difference between the two than there is among the different species of *Lycopodium*. This new *Equisetum* prothallus certainly disposes of the sharp distinction hitherto drawn between the sexual generation in the two great groups Equisetales and Lycopodiales, which, from other facts, have long been regarded as having had a common origin from the remarkable extinct group Sphenophyllales.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon), F.I.C.

MEDIAEVAL SEALING WAX.—In the annual report of the Government Chemist for 1913-1914, recently issued as a Parliamentary Paper [Cd. 7562, pp. 1-25] an interesting account is given of analyses of old wax impressions

on documents in the Public Record Office. The seals examined dated from the thirteenth to the eighteenth century, and differed but little from modern sealing wax. Most of them consisted of a mixture of beeswax and resin, others of pure beeswax. Two seals, of the dates 1399 and 1423 respectively, were composed of wax, the characteristics of which agreed more nearly with those of East Indian than of European beeswax. The wax composing an impression from the Great Seal of 1350 agreed in chemical and physical characters, with pure beeswax of to-day. The pigment in the red seals was vermilion, while the green seals contained verdigris.

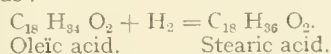
THE BRITISH COLOUR INDUSTRY.—As the outcome of the deliberations of the Committee of Chemical Manufacturers, appointed in August last, under the chairmanship of the Lord Chancellor, a meeting was held on November 10th of representatives of the principal firms engaged in industries involving the use of coal-tar dyes. At this meeting a scheme was suggested for the formation of a limited company, the capital for which was to be mainly subscribed by the consumers of dyestuffs, while the Government was prepared, conditionally on this being done, to subscribe part of the share capital and to guarantee the interest on a large issue for a certain number of years. The British control of the undertaking would be preserved, and steps would be taken to prevent the enterprise from interfering with other branches of chemical industry.

It was also announced that the Government was taking preliminary steps to acquire dye-producing works in this country for the purpose of the proposed company, and that arrangements would be made for the transfer of other concerns to its control.

The principle of the proposal was unanimously adopted by the meeting, and a small committee was formed to confer with the Board of Trade as to the methods of developing a scheme upon the lines suggested.

THE HARDENED OILS INDUSTRY.—The solution of the problem of converting fluid oils into solid fats has led to one of the most important developments of industrial chemistry during the present century.

Although the unsaturated fatty acids in oils, typified by oleic acid, will readily absorb iodine or oxygen, they long resisted all attempts to make them combine with hydrogen to form solid saturated fatty acids, typified by stearic acid, thus:—



Some details of the way in which the difficulty was overcome have already been given in these columns. The oil is heated in a finely divided state in a current of hydrogen, preferably under pressure, and in the presence of a metallic salt, such as a compound of nickel or palladium, which acts as a catalytic agent, and effects the combination between the hydrogen and the fatty acid. Any desired degree of hardness can thus be imparted to the fat, and evil-smelling fish oils are rapidly converted into hard, odourless tallow.

Enormous quantities of hardened oils are now manufactured in Europe and the United States. In Germany the largest factories engaged in hydrogenating oils are at Bremen, where only edible oils are hardened to produce "Brebisol"; and the Germania Oil Works at Emmerich, which produce only technical products, sold under the names of "Talgol" and "Candelite," for the manufacture of candles and the like.

Interesting details of the development of the industry in France are given by the Consul-General at Marseilles (*Diplomatic and Consular Report*, No. 5377). The pronounced rise in price of coco-nut oil has led to an increasing demand for hardened oils, such as cotton-seed, sesame, and pea-nut oils, for the manufacture of substitutes for butter and lard,

in which coco-nut oil was formerly a principal constituent. So far, however, the industry is only just established in France, and has not met with as warm a welcome as in Germany or America.

The so-called "compound lard" in the United States is now mainly made from hydrogenated cotton-seed oil. According to Mr. E. Thomson (*American Perfumer*, 1914, IX, 139) the total capacity of plant for hardening oils in Europe is estimated at one million three hundred and seventy-five thousand barrels (of four hundred pounds), and the United States output at five hundred thousand barrels. Deodorised coco-nut oil is also being increasingly used for the purpose, in admixture with hydrogenated oils.

The hydrogen used for hydrogenating fats must be of a sufficient degree of purity, since traces of impurities, such as chlorine, arsenic, sulphur, and phosphorus, inhibit the reaction. In some of the larger works, according to M. Bontoux (*Les Matières Grasses*, 1914, VII, 4194), the gas is obtained by the electrolysis of alkaline distilled water, while in other factories it is prepared from water-gas or producer-gas. In the methods of Linde-Frank-Caro and of the Société de l'Air Liquide, hydrogen of ninety-seven to ninety-eight per cent. purity is obtained by the fractional distillation of the liquefied components of water-gas, and it is then brought to a purity of 99 to 99.5 per cent. by being passed over soda lime at 180° C. The trace of oxygen still remaining in the gas is negligible. Another method of preparing hydrogen for the purpose is Lane's process of decomposing steam by red-hot iron, the resulting iron oxide being subsequently reduced again by the elements of water-gas.

A complete plant for hydrogenating about fifteen tons of oil a day costs about £15,000, and the cost of hardening a hundredweight of fat ranges from 1s. 2d. to 3s. 2d., according to the process, the nature of the original oil, and whether the hydrogenated fat is intended for food or for technical purposes.

GEOGRAPHY.

By A. SCOTT, M.A., B.Sc.

MUD-LUMPS.—In a recent "Professional Paper" of the United States Geological Survey (No. 85 B) E. W. Shaw gives an account of the remarkable clay formations which occur at the mouths of the Mississippi, and are locally designated "mud-lumps." Such an immense amount of material is brought down annually by the Mississippi, and deposited at its mouths, that land is built out at an estimated rate of three hundred feet per annum, and, consequently, the channels, islands, and bars are constantly changing their positions. The mud-lumps, however, differ from the usual delta deposits in a number of ways. They occur some distance off the shore, near the submarine bars at the various "passes" through the delta, and form islands up to an acre in extent. They rise in a few weeks to a maximum height of from two to eight feet above sea-level, and at first are elliptical in shape, but soon become irregular, owing to erosion by tide and river action. After attaining their maximum height, they become quiescent, and finally disappear as the result of being worn down by the water. Sometimes they appear to subside in much the same manner as they rise.

The central core of the "lumps" is composed of a sticky bluish-grey clay, very fine-grained, and containing little of the coarser delta deposits. Surrounding this are various beds of sand and silt, which have been thrust up in an anticlinal fashion by the rise of the core. The whole is very much fissured and faulted, but the clay itself is structureless, and contains practically no organic remains. Apparently connected with the fissures are numerous active mud-springs, which discharge salt, "sludge," and gas. The gas is mainly methane, with subordinate amounts of nitrogen, oxygen, and carbon dioxide, and seems to be formed by the decomposition of organic material.

Various theories have been put forward to account for their origin. They cannot be uplifted by subterranean gas, as borings have failed to reveal any gas reservoirs, while their uniform height and occurrence only at the ends of the "passes" also militate against such an origin. The most probable explanation is that they are due to the seaward flow of a semi-fluid clay under the shallow water near the ends of the passes, and that this flow is caused by the pressure of the sediments deposited by the river, the upward buckling being due to the resistance offered by the so-called "foreset" beds, which are comparatively thick deposits of coarse sandy material just off the shore.

CLARE ISLAND.—In one of the recent reports on the Clare Island Survey, T. Hallissy gives an account of the geology of the island. The effects of differential weathering are well shown by the rugged nature of the surface, the knolls and ridges generally consisting of hard, gritty rocks, while the valleys and depressions are formed in soft shales. There is abundant evidence to show that the island was covered by the Central Irish glacier at the period of maximum glaciation, *roches moutonnées* and glacial striae being found at considerable heights above sea level, while the lowest superficial deposit on the island is a fine-grained, compact boulder-clay containing many striated blocks of limestone. The presence of the limestone shows that the direction of the invading ice was a little south of west, and confirmation of this is obtained from the facts that the axis of a large drumlin on the south side of the island is in the same direction, and that the polished sides of the *roches moutonnées* face eastwards. The presence of a coarser boulder-clay above the compact deposit indicates a later glaciation, which seems to have been of local origin, as the boulders are mainly granite and serpentine, which can be matched by rocks occurring close by on the mainland. There are also a number of Post-Glacial deposits, such as blown sand, peat, and alluvium, the peat containing numerous trunks of Scotch fir.

The island may be divided into two parts: a low-lying tract, which seems to be part of the great Carboniferous peneplain of Central Ireland, and the highlands, which are probably remnants of the Pre-Carboniferous plateau. Although the island was separated from the mainland until the Glacial period, a Post-Glacial connection with the mainland is most probable, as the intervening strait is very shallow, the bottom being about the same horizon as the submerged forests which are common in the district.

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

CHIASTOLITE IN SOUTH AUSTRALIA.—A great find of chialstolite crystals at Bimbowrie, South Australia, recently made by Mr. G. R. Howden, is fully described by Dr. (now Sir) Douglas Mawson in the *Memoirs of the Royal Society of South Australia*, Volume II (1911). The crystals occur in a schistose rock, and in two localities they have weathered out from the matrix in such quantities that the ground is thickly strewn with chialstolite as a residual surface mantle. "The properties of hardness and resistance to decay of chialstolite, the comparative softness of the matrix, and the arid conditions fostering wind erosion, and thereby removing the finer products of disintegration, all promote the accumulation of such a chialstolite mantle." The crystals have been produced by the thermal metamorphism of a Cambrian slate in contact with both acid and basic intrusive igneous rocks. The crystals are of huge size. Some fragments picked up were seven centimetres in diameter; others were eighteen centimetres long. Many of the crystals are distorted owing to the crushing of the matrix. The cross-shaped zones of inclusions characteristic of chialstolite are well shown in these crystals. An interest-

ing mode of alteration to an intimate mixture of muscovite and corundum is also recorded.

ROCKALLITE.—The lonely island of Rockall, situated in the North Atlantic, about one hundred and seventy miles west of the Hebrides, and about half-way between Ireland and Iceland, is largely composed of a unique igneous rock, which has been termed "rockallite." This rock was described and named by Professor J. W. Judd in 1897. Only two landings had previously been made on the island, and in these two cases it was only possible for sailors to jump from a boat on to a projecting point of rock and to knock off pieces, which they threw into the boat. An expedition of 1896 was unable to land, but a landing was effected a few years ago, when a liner from North America ran on to it, and was wrecked with loss of life. Had a geologist been present amongst the survivors the opportunity would doubtless have been taken to secure more specimens.

Professor Judd described the rock as a holocrystalline admixture of soda-pyroxenes (aegirine and acmite), albite feldspar, and quartz, named in the order of crystallisation. As the original chemical analysis of this rock was incomplete, and as it is of unusual systematic importance, Dr. H. S. Washington has made a new and complete chemical analysis (*Quarterly Journal Geological Society*, June, 1914), which has disclosed some interesting features. Both analyses show high silica, ferric oxides, and soda, combined with low alumina, ferrous oxide, magnesia, lime, and potash; but Dr. Washington's analysis, too, also demonstrated the presence of unexpectedly large amounts of the rare minor constituents, zirconia and ceria, which occur to the extent of 1.17 and .37 per cent. respectively. Since minerals noted for the abundance of these constituents are absent, it is concluded that they must be contained in the pyroxene.

The rock is a highly sodic variety of the alkali-granites, and is comparable to aegirine-granites from Madagascar and Corsica. In the American Quantitative Classification it falls into the sub-range "rockallose"; and an indication of the exceptional character of the rock may be found in the fact that the two analyses of rockallite are the only representatives of this sub-range amongst eight thousand analyses of igneous rocks collected by Dr. Washington.

ÆGIRINE AND ACMITE.—The presence of zirconia and ceria in rockallite and the ascription of these constituents to the pyroxene present in the rock lead to the interesting speculation that they may be the cause of the differences between aegirine and acmite. Both of these pyroxenes occur in rockallite, and they are unquestionably closely related chemically, crystallographically, and optically; but there are marked differences in colour and in character and strength of pleochroism, indicating a certain chemical difference between the two. Dr. Washington suggests that the presence of zirconia and ceria may be characteristic of acmite, and the cause of its difference from aegirine. Acmite is a brown mineral, whereas aegirine is green. It is pointed out that all cerium-rich silicate minerals, such as melanocerite, allanite, cerite, mosandrite, and rinkite, are yellow or yellowish brown, with weak pleochroism. Similarly the zirconia-bearing pyroxenes, such as rosenbuschite, lävenite, wöhlerite, and hiortdalite, are all yellowish, and have weak pleochroism. It is possible, therefore, that ceria and zirconia form an essential part of the molecule of the brown acmite, whilst they are wanting in the green aegirine. This is, however, merely a suggested hypothesis, and needs to be tested by chemical study of aegirine and acmite, which is being undertaken by Dr. Washington.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

THE WEATHER OF JANUARY.—Dr. C. Leeson Prince, who was for many years a very keen observer in

Sussex, in his books on the Climate of Uckfield and of Crowborough (1898) succinctly described the meteorological character of the several months of the year. With regard to January he said that "previous observations stamp this month as the coldest month of the year, and in severe winters, when there has been little or no frost in the previous December, the cold usually commences during the first or second week, accompanied by a keen north-east wind. Should a change not occur in the course of two or three days, we are nearly certain of having a fall of snow and a continuance of the frost. In our very uncertain climate we occasionally find that great mildness prevails during the month. This was especially the case in the years 1846, 1851, 1853, 1866, 1877, 1884, and 1890. In 1846 and 1866 the weather was often too warm to bear fires with comfort. Very strong south-westerly winds are frequent in such a season, which increase to a hurricane if long continued, and occasion great depression of the barometer. On the other hand, we had very cold weather in the years 1850, 1861, 1867, 1871, 1881, 1891, 1893, 1895, and 1897."

It may no doubt be of some interest to have a few facts about the weather of the month of January, so the following particulars, which are based on the Greenwich records, may be of some service; but it must be understood that they are not intended to be taken as a forecast of the weather for the present month.

The average mean temperature for January is $38^{\circ}\cdot6$, in 1884 it was as high as $43^{\circ}\cdot9$, while in 1881 it was as low as $31^{\circ}\cdot7$. The average maximum temperature is $43^{\circ}\cdot1$; the highest mean was $48^{\circ}\cdot5$ in 1890, and the lowest $35^{\circ}\cdot1$ in 1879. The average minimum temperature is $33^{\circ}\cdot7$; the highest mean was $39^{\circ}\cdot4$ in 1846, and the lowest $27^{\circ}\cdot3$ in 1881. The absolute highest temperature recorded during the period was $57^{\circ}\cdot0$, in 1843, on the 28th, and the absolute lowest $16^{\circ}\cdot7$, in 1841, on the 8th. The average number of days on which the temperature falls to or below the freezing-point is twelve; and there are on the average two days during which the temperature remains throughout the day continuously below the freezing-point.

The average rainfall for the month of January is 1.80 inches; the greatest amount was 4.35 inches in 1877, and the least 0.26 inch in 1880. The heaviest fall in one day was 1.61 inches in 1866, on the 11th. The average number of "rain days" (*i.e.*, on which 0.01 inch fell) is 14.8, the greatest number of days was twenty-three in 1877, while the least number was five in 1858. Snow falls on the average on four days.

Barometric records for London go back to the year 1774, and from these we find that the mean pressure for January is 29.965 inches: the highest mean was 30.387 inches in 1779, and the lowest mean was 29.581 inches in 1800. Barometric pressure is often subject to great variation, and the extreme readings for the year have occurred in the month of January. The highest recorded reading in the British Isles was 31.110 inches, at Aberdeen in 1902, on the 31st, and the lowest recorded reading was 27.332 inches, at Ochertyre, Crieff, in 1884, on the 26th.

"As the day lengthens,
So the cold strengthens."

"If the grass grow in Janiveer,
It grows the worse for it all the year."

VISIBILITY AS A SIGN OF RAIN.—Letters from several correspondents have appeared in *Symons's Meteorological Magazine* on the subject of the haziness of the atmosphere with certain winds, and also of remarkable clearness as a sign of rain. With regard to visibility as a sign of rain, it may be pointed out that this matter was dealt with by the Honourable Ralph Abercromby and W. Marriott in their joint paper on "Popular Weather Prognostics" (1882). They showed that in the wedge-shaped area of high barometric pressure, which is frequently

formed between a retreating and an advancing depression, there is often great visibility with a cloudless sky, which occurs during the very fine weather on the east side of the wedge-shaped area. They quoted a number of weather sayings, or prognostics for rain, which they considered were to be explained by this condition of barometric pressure. The reason of "visibility" is uncertain; the old idea, that it was due to excess of vapour, is no doubt erroneous. The dry and wet bulb hygrometer always indicates a considerable amount of dryness when it is remarked.

There is another distribution of barometric pressure with which visibility as a prognostic of rain occurs, and that Abercromby and Marriott called "straight isobars." Although there is little rain actually with these, the area which they cover to-day will probably be covered by a depression to-morrow, the conditions being favourable for the passage of depressions. With this type there is often great visibility with a hard overcast sky and moderately dry air, in which the stratus seems to play the part of a sunshade, for as soon as the Sun comes out the clearness of distant objects diminishes. This visibility should not be confounded with the visibility with a cloudless sky, which occurs with wedge-shaped isobars.

VERIFICATION OF THERMOMETERS.—The testing of meteorological instruments, which was for so many years carried out at the Kew Observatory, has been transferred to the National Physical Laboratory at Teddington. New apparatus has been installed for the testing of thermometers, and this has led to a great gain in the rapidity, accuracy, and convenience of testing. The new equipment consists of a water-bath capable of taking vertically seventy-two thermometers, a steam bath for six thermometers, two ice-baths, a horizontal bath, and a low-temperature oil-bath, which latter is in the experimental stage. This oil-bath was designed in view of the increasing amount of low-temperature work. It consists of two adjacent compartments, the intervening partition being pierced with holes top and bottom. One compartment contains a cooling worm and a propeller stirrer; the other contains the thermometers under test. The readings are observed through a double window, the device being necessary to prevent condensation of dew on the glass. The cooling worm is connected through a small rotary cog pump with a second worm, immersed in a freezing mixture of ice and salt. The circulating liquid is paraffin oil. The design permits temperatures as low as about 7° F. in the testing bath. The liquid chosen for the bath is ordinary paraffin oil. Odourless paraffin oil was first tried, but it exhibited a cumulative increase in viscosity with use, which effectually prevented its application to the purpose. Already about a thousand thermometers have been tested in this bath, and, with the experience gained, it is proposed to draw up designs for a new bath to take its place among the permanent equipment. The total number of meteorological and other thermometers tested during the year 1913-14 was eight thousand and sixteen.

ATMOSPHERIC POTENTIAL GRADIENT.—Mr. W. A. D. Rudge, in a paper to the Royal Society on "Some Sources of Disturbance of the Normal Atmospheric Potential Gradient," states that, besides rain, hail, and snow, there are other factors, such as dust and steam, which may produce sudden variations of the atmospheric potential gradient. From numerous experiments which he has carried out in various places he finds that the presence of dust in the atmosphere has the effect of altering the potential gradient, sometimes increasing, sometimes diminishing, the positive value. The dust from well-used old roads practically always increases the positive potential. Manufacturing operations, which result in the production of dust, disturb locally the potential gradient. The presence of clouds of steam increases the positive potential, and the effect persists for some time after the steam has condensed.

CONTINUOUS PICTURES OF THE WEATHER.—Professor Cleveland Abbe, in a note in the United States *Monthly Weather Review* on continuous pictures of the weather, said that he is convinced that it is only by the study of atmospheric conditions over the whole northern hemisphere, as if photographed daily, that we shall ever be able to appreciate the preponderating influence of the diurnal rotation of the Earth, and the general circulation of the atmosphere as compared with the minor influence of sunshine, radiation, and moisture. That is to say, these last three influences that start the atmosphere in motion are completely overshadowed by the effect of that motion combined with the swift rotation of the Earth. The relative importance of these influences on the atmosphere as a whole is quite analogous to their relative importance in the case of a hurricane, where sunshine, moisture, heat, radiation all come into play, and would of themselves start the atmosphere into direct lines of motion toward a centre of low pressure, whereas the rotation of the Earth turns that radial movement into an almost perfect circle. The relative importance is analogous to the influence of gravity on a bowlful of water escaping at the outlet, where the least deviation from symmetry converts the straight line into a circular motion.

Atmospherics is not merely a study of the physics of the atmosphere on the scale of a laboratory experiment; it is a problem in terrestrial physics in which the overpowering influence of the Earth, considered as a small planet, must be fully considered. The lower layers of the atmosphere, being resisted by continents and highlands, move almost independent of the upper layers that have scarcely any connection with the lower layers by way of viscosity of fluid friction, and still less connection due to terrestrial resistances. These upper layers are affected by radiation and absorption, by density, by the attraction of the Earth, the Moon, and the Sun, by the action of solar electrons and cosmic shooting stars, and by the motion of the Earth in space, as well as its diurnal rotation. Their motions represent the sum total of astronomical and planetary influences, and they react in a most complicated manner upon the lowest layer of the atmosphere, which is under the influence of convective circulation. The study of the motions of the centres of high and of low pressure, presented to us every day on these international polar charts of the northern hemisphere, may be conducted either by pure analysis, or by graphic methods, or by laboratory experiment.

MICROSCOPY.

By F. R. M. S.

ANTENNAE OF THE ICHNEUMONIDAE.—The function of the antennae of insects has long been a matter of conjecture, some entomologists being of opinion that they are organs of perception, others thinking that they may be organs of smell, of touch, or of communication with their fellows; but as such of these senses which we possess are excited in us by various degrees of vibration, it is quite possible that the antennae are the means of conveying to the insect impressions which, whilst they correspond in method, are more highly sensitive, and respond to vibrations to which none of our own sense-organs are attuned. Careful observation inclines to the belief that the curious retractile terminal joints of the antennae of the female mosquito and the similar organs found on the palpi of a tick enable them to ascertain, with unerring precision, the position of the blood-vessel which they desire to pierce. No one can have watched the tremulous filiform antennae of a tiny ichneumon-fly, as it searches for the hidden pupa of the clothes-moth, without being impressed with the idea that they are at least organs of smell by which these restless insects discover their victims, piercing and laying eggs within them, and in this way contributing so largely to the keeping down of what would otherwise be a too numerous

pest; and since, according to "the Cambridge Natural History," some six thousand species of ichneumonidae are known, of which twelve hundred are British, our indebtedness to them can hardly be overrated. In relation to this subject, a microscopical examination of the mounted specimens in our own cabinet shows that all the ichneumons there have in each joint of the antennae, except the terminal and the three nearest to the base, several remarkable sigmoid bodies, as represented in Figure 17, the nature of which is at present obscure. Each of these has a very clearly defined elliptical centre, the average number in each joint being three, some of which are straight throughout; but the majority are curved in opposite directions towards the ends, their measurement being from $\frac{1}{200}$ to $\frac{1}{150}$ of an inch in length, with a breadth of not more than $\frac{1}{2000}$ of an inch. The particular antenna from which Figure 17 is taken consists of forty-five joints, and is furnished with short hairs. As mounted in Canada balsam under pressure, it appears of a brown colour, the bodies in question being white in contrast.

R. T. L.

THE DRAGON-FLY (*AGRION PUELLA*) (*continued*).—The nymph undergoes a series of moults during its life in the water, and the changes during its early periods are difficult to describe, owing to this portion of its life's history being obscure.

Some species of Dragon-fly moult immediately they leave the egg, as in the case of *Agrion puella*, and, as mentioned earlier, the legs are adherent previous to this moult: these organs are eventually, however, set free, and the young nymph at once makes use of them.

In *Aeschna cyanea* the moults have been recorded to take place practically every four weeks in the first part of its life; later on changes occur every few days. In one case the nymph increased in size as follows:—

July 30th, 6½ millimetres; July 31st, 10 millimetres; August 3rd, 13 millimetres; August 15th, 18 millimetres (rudimentary wing-cases appeared); August 25th, 20 millimetres; September 22nd, 25½ millimetres; after winter rest, January 24th, 29 millimetres; May 5th, 32 millimetres; June 6th, 38 millimetres; July 14th 43 millimetres; the total number of moults being twelve, an average of 4 millimetres for each ecdysis.*

In *Agrion pulchellum* the moults numbered about fifteen, and the number of days required to complete the whole series in one case was over six hundred, whereas in other cases between three hundred to three hundred and thirty were necessary (see Table 6).

The average length of the nymphs varies somewhat, and reaches 18 millimetres in the final stage; smaller nymphs are known to measure only 14 millimetres. There is no complete regularity to be observed, for a period of stagnation may take place, which results in drastic changes in the final measurement of body length (see Figure 19)

The growth of the nymph's antennae is remarkable, and takes place in the segment immediately above the scape, i.e., the third from the base, which divides three times to produce new segments. The actual change is not really instantaneous, but by slow degrees forms under the hard shell the new parts, and these changes are in a sense connected with the various moults.

The percentage in the first stage shows an average of twenty-three for body length, but in the final stage this percentage decreases to twelve.



FIGURE 17.
Part of the
Antenna of an
Ichneumon-
fly.

* *Knowledge*, 1902. East, pages 198, 199.



From a photograph

by W. J. Lucas, B.A., F.E.S.

FIGURE 18.

Dragon-fly (*Aeschna cyanea*) with a fly held in its jaws. $\times 3$.



FIGURE 20.

Mouth-organs of the nymph of *Aeschna grandis* showing antennae and maxillae. $\times 2$.



FIGURE 19.

Nymph of *Aeschna grandis* (full-grown). $\times 17$.



FIGURE 21.

The three legs of the nymph of *Aeschna grandis*. $\times 17$.

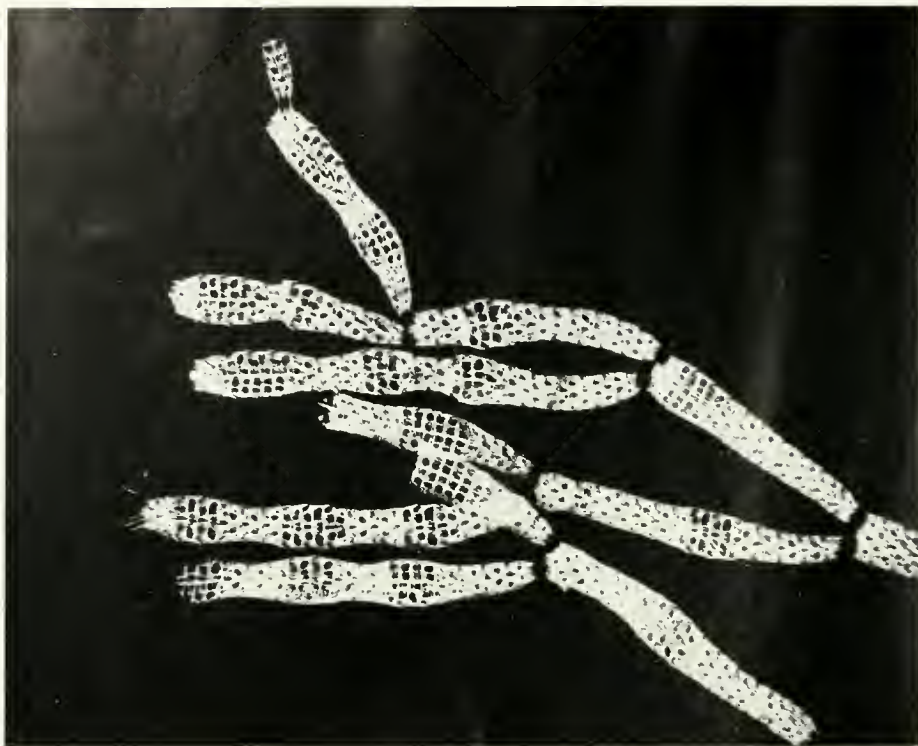


FIGURE 22. A Zoöphite, *Cillaria rigida*. $\times 20$.
Showing the interior of the skeleton.



FIGURE 23. *Cyclammina cancellata*. $\times 20$.



FIGURE 24. *Massilina secans*. $\times 30$.

Foraminifera showing the internal chambers.

From sciagraphs by J. E. Barnard, F.R.M.S.

The development of the wings takes place in later stages, and can be easily identified on the second and third thoracic segments as dark ridges or plates: they result from the

Expansion takes place, and this is due to the injection of fluid into the veins; the latter spread further and further apart, the folds becoming effaced: this takes about fifteen

TABLE 6.

	Stage 1	2	3	4	5	6	7	8	9	10	11	12	13	Total.
Nymph 1 Sex ♂	12 days	17	14	25	150	31	22	5	21	30	86	—	211	624
" 2 " ♀	8 "	14	18	60+	19	20	8	14	20	41	—	—	—	222
" 3 " —	11 "	24	55	17	4	10	7	8	9	22	87	37	217	508

upward growth of the pleura of the meso- and metathorax.

In the final stages long wings appear, and the antennae consist of seven segments.

The transformation of the nymph into an adult insect provides an interesting opportunity for observations, and can be watched, owing to its occupying some time. The change takes place out of the water, and the nymph seeks out some support, such as a branch or stem of a plant, several feet away from its former home, *viz.*, the pond.

The eyes of the nymph, within a very short period, undergo a remarkable change, and become bright instead of dull, whereas, in the early stages, they seem to appear opaque, owing to the pressing close to the sockets of the eyes of the Fly.

The plant is grasped by the two hooks on the legs (see Figure 21), and it holds on firmly with its body in a vertical position; when fixed close to the stem internal changes take place.

In about ten minutes after drying, the thoracic skin splits, and the thorax of the fully formed Fly becomes visible through this opening.

The new thorax swells visibly, and, acting as a wedge, helps to enlarge the opening, which soon extends to the fore edge of the thorax; then it splits along the neck, and, finally, to the level of the eyes. At this point lateral openings proceed on either side.

The head becomes distended and completely withdrawn, appearing so large that one has great difficulty in believing that it was enclosed in so small a space previously.

When the head and thorax become free, the legs are carefully drawn out of their sheaths; and to assist this process the Dragon-fly, when emerging, bends backward until the whole body length is held only by the hindmost segments, which still remain enclosed in the larval skin.

The whole insect hangs, with six segments of the abdomen exposed—these segments are wet and limp—from the dry nymph skin, still clinging to its support by its stiff and empty legs.

In less than half an hour the body becomes arched considerably by the sudden spring of its whole length in the opposite direction, and the empty nymph skin is seized by the legs, which hold on to the sides of the opening firmly. The hinder part of the body, consisting of the remaining four segments of the abdomen, is withdrawn, and the insect hangs by its legs only.

At this stage the emerging insect appears to be somewhat deformed, and the abdomen is not quite so long as that of the insects already flying in the fields.

The wings, which seem to be very large when compared with their size, when enclosed in their nymph skin are turned edgeways, folded like a fan along their length, and, transversely, they at once begin slowly to expand. At first they appear dull and mealy-looking, but, as they lengthen, a flatter and clearer look results, until in about thirty minutes they show all the beauty of their gauzy outline, but are still pale green and soft, like the body.

As the fluid which fills the insect is exuded, drop by drop, the limp appearance vanishes, and the body stiffens and becomes dry.

The wings also dry, and become placed in their final position, but are not spread out; for though they afterwards become stiff, and as firm as talc, they are still wet, and soft as paper.

minutes, and at the same time the abdomen is gradually lengthened.

It is more than two hours before the wings can be spread horizontally, and from two to three hours more before they can support the weight of the body.

When first emerged the Dragon-fly is very faint in colour, but its brilliancy and distinctions of colouring gradually increase.*

When the wings and body have dried and hardened, the insect starts away swiftly on a level course, wheeling sharply to the left or the right, and backing with ease and facility.

In the pond the nymph preyed on other aquatic inhabitants, and now in the air winged insects form its prey.

Figure 18 (*Aeschnura cyanea*) shows the insect with a Dipteron held in its jaws. This was obtained by one of our well-known authorities on the Odonata (Dragon-flies) and kindly lent to the writer.

W. HAROLD S. CHEAVIN, F.R.M.S.

CORRIGENDUM.—In the December issue (Volume XXXVII), page 434, the descriptions of Figures 420 and 421 were interchanged.

THE QUEKETT MICROSCOPICAL CLUB.—At the five hundred and second ordinary meeting of the Quekett Microscopical Club, held at 20, Hanover Square, W., on November 24th, the President (Professor Arthur Dendy, D.Sc., F.R.S.) first called upon the meeting to pass a resolution expressing the members' deep regret at the loss they had sustained by the death of Doctor M. C. Cooke, M.A., LL.D., A.L.S., which occurred on November 12th, at his residence in Southsea.

Dr. Cooke, known as the "Father of the Club," was one of the eleven members who attended the preliminary meeting of the Quekett Microscopical Club held on June 14th, 1865, and he was elected one of its first Vice-Presidents. He was President in 1882 and 1883, and was elected an honorary member in 1893.

Mr. J. Grundy introduced and explained the great advantages of a micrometric table by Mr. E. M. Nelson. This table, published by Messrs. H. F. Angus & Co., 83, Wigmore Street, London, W., price 3d., contains full particulars relating to its use. Its utility is that, having taken the reading from the eyepiece micrometer and that of one division of a stage micrometer in the divisions of the eyepiece micrometer, on reference to the table, the size of the given object is obtained at once without any further calculation. At the conclusion of Mr. Grundy's lucid explanation, Mr. Ainslie, R.N., concurred as to the utility of the table.

Mr. D. J. Scourfield, F.R.M.S., read a paper upon a new Copepod found in water from hollows in tree-trunks. He stated that in recent years, owing to endeavours to discover the life-histories of mosquitoes and other insects, supposed to be connected with the dissemination of tropical diseases, much attention has been given to the subject of the little animals found living in the water of these little hollows. According to a recent paper published by Picado no fewer than two hundred and fifty species of animals have been found living in this peculiar environment, forty-nine being new to science. They belong to almost all groups of invertebrates, but naturally insects and their larvae predominate.

* "Natural History of Aquatic Insects," Miall, pages 340-45.

Mr. Scourfield pointed out that in tropical forests ponds and water on the ground are rarely met with, and it was difficult to locate the breeding places of mosquitoes until it was found to be in water held in the little cups on the tree trunks and roots.

When he first commenced to search for Entomostraca in these situations his curiosity was rewarded by finding the remarkable blind Copepod (*Belisarius viguieri*), which had not previously been found in this country. He was now able to report that on several occasions he had found a new Copepod in such little reservoirs of water on trees in Epping Forest, and up to the present they have been found nowhere else.

The new species evidently belongs to the Harpacticid genus *Moraria*, described by T. and A. Scott, and so named because first found in Loch Morar, Scotland. Eight species are known, three of which have been found in the British Isles. He stated that he proposed to call it *Moraria arboricola*, because of its tree-dwelling habit. It is a very small form, the female measuring only about one-fortieth of an inch in length, of the type of *Cyclops*, *Canthocamptus*, and *Diaptomus*.

The genus is peculiarly adapted to exist in but little water, and when placed in this element could not swim at all well, but wriggled about rather than swam.

In Mr. Scourfield's experience, the specimens are mostly found in the early part of the year.

Replying to questions he stated that he could give no information as to how they spread from place to place; that it must be supposed that they resisted the effects of evaporation, as do similar creatures whose eggs and adult forms dry, and become embedded, and remain for long periods in a condition of suspended animation. He also pointed out that one species of *Cyclops* and one of *Canthocamptus* form a kind of cocoon. He commented upon their wonderful vitality. In one case specimens left in a bottle were kept alive for four years by simply renewing the water from time to time to make up for evaporation.

The five hundred and third ordinary meeting of the Quekett Microscopical Club was held at 20, Hanover Square, W., on Tuesday, December 22nd, Professor E. A. Minchin, M.A., F.R.S., Vice-President, in the chair.

Mr. J. Grundy, F.R.M.S., read a communication from Mr. E. M. Nelson of interest to metallurgists. A slide was exhibited, consisting of a thin aluminium disc of about one millimetre in diameter, mounted by itself. When placed under a $\frac{1}{4}$ - or $\frac{3}{8}$ -inch objective, and illuminated by one of the universal condensers, lamp, and bull's-eye, a strong top-illumination is obtained by reflex light from the front lens. Mr. Nelson points out that the idea is not new, having been expounded by Rainey sixty years ago; later by Professor B. T. Lowne; and again, more recently, by Mr. J. W. Gordon at the Royal Microscopical Club. He suggests that if, instead of using a cubic half-inch of metal, a piece of wire, say, 1.5 millimetres thick, were polished and stuck on a slip, it could be investigated quite as well.

Mr. J. Wilson, F.R.M.S., read some notes by Mr. H. Whitehead, B.Sc., on an epizoic infusorian (*Trichodina steinii* C. and L.) found on Turbellaria. Examples were discovered on a specimen of *Mesostoma tetragonum* moving about the body and between the folds, closely allied to *T. pediculus*, differing only in that the latter has an inner as well as an outer ring of teeth. The body varies considerably in shape; when at rest it is cylindrical (sloping), with the base diameter equal to height, about 40 μ . The basal circle of cilia is in contact with the host; the adoral cilia form a spiral leading to the mouth. When free-swimming, the adoral cilia are retracted, and the basal cilia used for locomotion. The protoplasm contains a number of spherules and one or two contractile vacuoles. The nucleus is large and horse-shoe-shaped, and only seen when stained.

Mr. Whitehead pointed out a discrepancy in Saville Kent's description, probably taken from Claparède and Lachmann, who stated that the posterior horny ring was continuous and denticulate only on its outer edge, whereas

it consists of an outer circle of cilia, and within this a circle of from eighteen to twenty chitinous teeth, with points directed outwards.

Vejdorsky confirmed this point in 1881, and stated that he had found *T. steinii* on *Planaria gonocephala*. There is no evidence of parasitism or inconvenience to the host; therefore the non-committal term "epizoic."

Mr. J. Burton read a paper by Mr. E. M. Nelson on "Palaeozoic Fungi," the chief object being to draw attention to a comparatively new and interesting field for microscopists. Owing to real fossils from a microscopic point of view only having been discovered during the last twenty years or so, real fossils meaning those in which the cell-structure has resisted the disintegration of carbonisation, there is ample scope for more workers in this branch. It was a most interesting paper, but space prevents more than one illustration of its treatment of palaeobotany. In Mr. Nelson's possession is a slide containing a section of a small seed with the pollen grains in the pollen chamber, just previous to fertilisation, although fifty million years must have passed since they entered. The tracheides and the bordered pits in the cells are also well preserved. He recommends those wishing to take up this subject to read Dr. D. H. Scott's book, "Studies in Fossil Botany" (two volumes; Black).

Mr. Burton referred to a slide, exhibited before the members, of a section of the leaf of *Epidodendron harcourtii*, upon which was observed a brown oval ball. A power of 200 showed that it was in part formed by little rods, somewhat interlaced, not unlike the house of the Caddis Worm. They are found singly, but more often in groups, particularly where the leaf's cell tissue has disintegrated. As no mycelium has been observed, it is not possible to state if the invasion of the leaf took place before or after it had fallen. Mr. Nelson considers it to be a sort of fungus spores (gonidia), a conclusion not considered satisfactory by certain of the members.

Mr. G. K. Dunstall, F.R.M.S., showed a live specimen of the Rotifer (*Callidina bilfingeri*), which has only twice previously been seen in England. F. E. R.

THE LIMITS OF MICROSCOPICAL MAGNIFICATION.—At the meeting of the Royal Microscopical Society, held on December 16th, Mr. J. E. Barnard read a most important paper on "X-Rays in Relation to the Microscope." It is certain that the sciagraphs, principally of foraminifera, exhibited as illustrations, were very much more successful than any others of minute objects which have previously been produced. They have, moreover, a very considerable value, inasmuch as the internal arrangements of the chambers of the shells can be determined by their aid without making a section of the shell, and so sacrificing what might be a unique specimen. Mr. Barnard has kindly lent us the negatives from which Figures 22-24 were made.

The point of the paper, however, which gives it its claim to the title "epoch-making," applied to it by the Chairman (Mr. Edward Heron-Allen), is the possibility, emphasised by Mr. Barnard, of securing magnifications immensely greater than are now obtained by means of the ordinary microscope.

The wave-length of x-rays is some thousand times shorter than those of light, and if, as Mr. Barnard's researches suggest, those rays can be made to take the place of light, we should be able to get a magnification many thousand times as great as we do now. Mr. Barnard showed that x-rays can be refracted, as have also Messrs. Rankin and Chambers in the columns of "KNOWLEDGE" (Volume XXXVII, page 260); but it is rather with other invisible ways of greater wave-length, but still very much shorter than those of light, that it is suggested that practical results are most likely at first to be obtained. The investigations which will have to be made will be long, no doubt, and costly; but Mr. Barnard, who has by his suggestive paper thrown out ideas of which other workers may take advantage, is very confident of ultimate success.

PHOTOGRAPHY.

By EDGAR SENIOR.

DEVELOPMENT WITH FERROUS OXALATE
(continued from Volume XXXVII. page 436).—We have before us as we write some test negatives made in a sensitometer and developed with ferrous oxalate, and these show both good gradation and density, while the deposit is of good neutral tint, the formulae for the two solutions, and the strength of the developer employed, being as follows:—

No. 1.				
FORMULA FOR IRON SOLUTION.				
Ferrous sulphate	...	...	...	1 ounce
Water	...	...	...	3 ounces

No. 2.				
Potassium oxalate (neutral)	...	...	...	1 ounce
Water	...	...	...	3 ounces

Both solutions should be made with hot water, and the former slightly acidified with sulphuric acid, and the latter with oxalic. For development, four parts of number two were taken and one part of number one added. The mixed solutions were then poured over the exposed plate; when development was considered to have proceeded far enough, the film was rinsed; the plate was then placed in a saturated solution of common alum for about five minutes, and then well washed and fixed. If the alum bath is omitted a white deposit of oxalate of lime will be seen in the film. Various modifications of the method of using ferrous oxalate were also employed, and Dr. Liesegang recommended that in order to produce soft negatives from subjects having strong contrasts, the plate should be soaked for about two minutes in a plain solution of iron sulphate, to which was added about two or three drops of the dilute "hypo" solution to each ounce of the iron solution. At the expiration of a couple of minutes the sulphate solution was poured off, and one of potassium oxalate applied, when the image quickly appeared and rapidly gained the required density. When, however, the density was not sufficient, a little of the iron sulphate was added to the oxalate, and the mixture again applied to the plate. In cases where great brilliancy was the desideratum, the reverse method was adopted, the plate being first soaked in the oxalate solution for two or three minutes a little "hypo" being added to the oxalate and at the end of this time a full-strength oxalate developer was applied to the plate. By such means as these, as well as alterations in the proportion of ferrous sulphate used, variation in the type of negatives obtained could be made. When a still stronger form of ferrous oxalate is required, it may be prepared by the addition of solid ferrous sulphate to a saturated solution of potassium oxalate. It is, however, in the development of bromide paper that ferrous oxalate is likely to find its most useful application now; and, from considerable experience, the writer can thoroughly recommend the following formulae for general use in this direction:—

No. 1.				
Potassium oxalate (neutral)	...	...	...	875 grains
Potassium bromide	...	...	...	3 "
Water	...	...	...	8 ounces

No. 2.				
Ferrous sulphate	...	...	...	875 grains
Water	...	...	...	6 ounces
Strong sulphuric acid	...	...	...	7 minims

For use six parts of No. 1 are taken and one part of No. 2 added. The mixed developer is then poured over the exposed bromide paper, when the image will develop gradually and of a good colour. When the development is almost completed the solution should be poured off into the measure, and the moment the desired result is obtained the print must be flooded with the following clearing solution:—

CLEARING SOLUTION.

Sulphuric acid	...	...	...	½ ounce
Water	...	...	...	80 ounces

or

Acetic acid	...	...	...	½ ounce
Water	...	...	...	80 ounces

Either of these solutions should be allowed to remain on the paper for one minute, when a fresh one is applied, which is allowed to act for a similar time, and, finally, a third one is applied for the same time. The print is then well rinsed and fixed in the following fixing bath:—

FIXING SOLUTION.

"Hypo"	...	...	...	3 ounces
Water	...	...	...	20 "

The time of immersion in the fixing bath should not be less than fifteen minutes to secure thorough fixing. Prints developed with ferrous oxalate have very clean whites and rich velvety blacks unless the exposure has been excessive, when a brownish tint may be imparted to the latter. In short, the only drawback to the use of this developer seems to be its slowness when compared with amidol, and the necessity for using three clearing baths.

PHYSICS.

By J. H. VINCENT, M.A., D.Sc., A.R.C.Sc.

DETAILS OF CRYSTALLINE STRUCTURE.—In 1912 Friedrich, Knipping, and Laue found that a narrow beam of x -rays sent through a slab of crystal on to a photographic plate produced a geometrical pattern of spots instead of only one, as would have occurred if the rays had been incapable of interference and reflection. The spots can be accounted for by regarding the rays as having a wavelength, and either treating the crystal as a three-dimensional diffraction grating, or as being capable of producing reflection from planes rich in atoms. The latter point of view was advocated by W. L. Bragg, who has done much to apply the new discovery to the investigation of the details of crystal structure. The simplest case yet studied is that of naturally crystalline copper, which was shown by W. L. Bragg (*Phil. Mag.*, September, 1914) to consist of atoms arranged as follows: At each corner of a cube whose edges are $3.6 \cdot 10^{-8}$ centimetres in length there is an atom, and also one at the centre of each of the square faces. The whole of the crystal is built up of a framework of atoms, all on the same plan, so that all these fourteen atoms will also figure as members of adjoining cubes. Such an arrangement is called "a face-centred cubic lattice."

A crystal is capable of reflecting x -rays when these strike the crystal at certain angles. Suppose a cubic section of such a crystalline scheme as the foregoing to be before the eyes; it will have five atoms on the top and bottom faces of the cube, and four on the plane midway between the top and bottom, so that planes rich in atoms run parallel to the faces of the cube. It is also seen that all of these planes have the same number of atoms per unit area. Now, if a beam of x -rays fall on the top face of an assemblage of a large number of atoms thus spaced, a reflected wave starts from the top layer. The waves are not wholly reflected; they travel on and strike succeeding layers, which in their turn send out reflected waves. If the wavelength λ , the distance apart of the layers l , and the angle between the face of the crystal and the x -rays or glancing angle θ be so related that each set of reflected waves loses a whole number of wave-lengths on the set reflected from the layer above, all these reflected waves will conspire together and the crystal will act as a reflector. This is so when

$$n\lambda = 2l \sin \theta_n,$$

where n is the number of wave-lengths lost by the successive sets of reflected waves, while θ_n is the particular glancing angle for this case. So that n corresponds to the order of the spectrum in an ordinary grating.

The wave-length of the x -rays used was $.573 \cdot 10^{-8}$ centimetres from a tube with an anticathode of palladium,

and θ was determined by recognising the reflected ray by the conductivity it imparts to a gas. On substituting the values for λ and θ in the equation, l is found for the distance between the layers of atoms in the crystal measured in definite directions. The results for l thus obtained, together with the density of the crystal and the mass of an atom of copper, provide all the data from which to calculate the details of the arrangement of the atoms in the crystal.

The x -ray spectrometer employed in such investigation was described in this column for December last (see Volume XXXVII, page 436).

APPLICATION OF INTERFERENCE TO THE STUDY OF THE ORION NEBULA.—In the October number of the *Astrophysical Journal* Buisson, Fabry, and Bourget give an account of a most remarkable research in which the étalon is employed in the study of the great nebula of Orion. The method consists in producing, with monochromatic light from the nebula, photographs of the nebula in light of one wave-length; while the photographs are marked simultaneously by the ring system of an étalon. By studying this system the exact wave-length of the light employed can be found. The comparison of this with the wave-length of the same line from laboratory experiments enables the motion in the line of sight to be calculated; slight distortion of the ring system yields data from which the local circulation of the material of the nebula can be deduced, while the number of wave-lengths over which interference takes place gives the temperature. By comparing these results for a known radiation with unknown ones the atomic weight of the unknown sources can be estimated.

The apparatus for the production of the photographs was mounted centrally in the opening of the tube of the large Marseilles reflecting telescope, so that the light proceeds from the objective to the apparatus without undergoing reflection. This disposition has the disadvantage that the total light is diminished; but by keeping the étalon and its mounting small, the loss from this cause was only a thirtieth of the whole amount of light. The pictures must be taken in monochromatic light; now the nebula gives out light giving a bright-line spectrum, so that any radiation could be isolated by means of suitable colour filters. One set of filters allowed only one of the hydrogen lines to pass; another allowed only a double line in the ultra-violet due to an unknown source to pass; while visual observations were also made on a green line, likewise of unknown origin. The filters were placed in the telescope tube between the objective and its focus. The light then passes through a rectilinear achromatic photographic lens of uvio glass whose focus coincides with that of the objective of the telescope. The rays emerge from this lens again parallel, but angularly magnified; the light now behaves as if it proceeded from a nebula still infinitely distant, but enlarged angularly eighty times. The light now goes through the étalon, and then through a second achromatic lens, which is again of uvio glass. This lens forms images of the rings and the nebula on the same plate placed in its focal plane. The picture of the nebula is eighty times as large as if it had been photographed directly by this last lens.

The chief results of the research are that the nebula is receding from the Sun at a velocity of 15.8 kilometres a second, while irregularities in the velocity at various parts may amount to ten kilometres a second. The ultra-violet double line is due to an element, "nebulium," of atomic weight about 3; the green line which was studied visually is due to another unknown element whose atomic weight is between 1 and 3. The temperature of the source does not exceed 15000° C.

RADIO-ACTIVITY.

By ALEXANDER FLECK, B.Sc.

CHEMICAL ACTION DUE TO RADIO-ACTIVE RADIATIONS.—It is a well-known fact that there are a number of chemical compounds which are split up into

their constituent elements when they are subjected to the rays from radio-active substances. For example, it has been found that thorium salts always give off carbon dioxide, which comes from traces of carbonate that have been retained from the manufacturing operations. Radium salts in aqueous solution also decompose the water and give off about 0.091 cubic centimetre of mixed hydrogen and oxygen per week per milligramme of radium element in solution. In a recent number of the *Comptes Rendus* (Volume 159, 1914, page 423) Scheuer describes another experiment, showing the power of the radiations to induce chemical activity. A mixture of hydrogen and oxygen in water-forming proportions was made, and subjected to the action of the rays from a quantity of radium emanation. After some time it was found that some of the gases had combined to form water. It is generally believed that all chemical reactions are "reversible"; that is, that none of the reacting substances will ever completely disappear; but that in some reactions, e.g., $2\text{H}_2 + \text{O}_2 = 2\text{H}_2\text{O}$, when the mixed gases are exploded, the reverse reaction cannot be detected. The above experiments with radium emanation suggest, however, that in these circumstances the reaction $2\text{H}_2\text{O} = 2\text{H}_2 + \text{O}_2$ proceeds with a speed comparable to that of the reaction $2\text{H}_2 + \text{O}_2 = 2\text{H}_2\text{O}$, and that with radium emanation hydrogen and oxygen become analogous to the usual text-book case of hydrogen and iodine, $\text{H}_2 + \text{I}_2 \rightleftharpoons 2\text{HI}$. It would be very interesting to find out whether this property of altering the state of equilibrium is general. It may be mentioned that chemical activity can be induced by both α - and β -rays, but that the α -rays are about twenty times as effective as the β -rays.

RATIO OF URANIUM TO RADIUM IN MINERALS.—That radium is genetically connected with uranium was shown by Boltwood and Strutt, who analysed a large number of minerals, and found that the ratio of the quantity of radium to uranium in rocks, which exhibit no appearance of the action of water or other disturbing agencies, is very approximately a constant value. An accurate knowledge of the value of this constant is of great importance in practical work on radio-activity, and a large number of determinations of it has been made. The value given in Rutherford's "Radio-active Substances" as the most probable is 3.4. This means that the amount of radium in equilibrium with one gramme of uranium is 3.4×10^{-7} grammes of radium. Various experimenters have found values from 3.1 to 3.8. In a recent paper in *The Philosophical Magazine* (September, 1914) Rutherford has been able to check former determinations with the International Radium Standard, and to correct the value of 3.4 to that of 3.23. This value seems to be the most accurate obtainable at the present time.

THE END-PRODUCT OF THE THORIUM DIS-INTEGRATION SERIES.—A few months ago the question of the atomic weight of lead from radio-active minerals was mentioned in these Notes, and it is now desirable to draw attention to the paper by Holmes and Lawson in the December number of the *Philosophical Magazine*, in which they discuss the question of the end-product of thorium. Soddy and Hyman found that lead derived from thorite had an atomic weight of 208.4, and this supported the view that this lead was a stable element derived from the disintegration of thorium. Holmes and Lawson attack the subject by the same method which led Boltwood to conclude that lead was the end-product of the uranium-radium series, i.e., by the relative quantities of the elements in minerals. In general, they consider the amounts of thorium, uranium, and lead in a large number of minerals whose geological age is known, and their results are: (1) The ratio of uranium to lead is constant, and (2) the ratio of thorium to lead is variable. In minerals, in which both uranium and thorium are present, they show that, owing to its slower rate of disintegration, the rate at which thorium would produce lead (assuming for the moment that lead is

the stable end-product of thorium) is 0.4 time the uranium rate. If that assumption were true, then it would be expected that in these minerals the ratio of lead to (uranium plus 0.4 thorium) would be constant. As a matter of fact, they find that this ratio is variable, and consequently they conclude that lead is not the stable end-point of the thorium series. The suggestion is made that bismuth is the end-product of the thorium series, and that thallium is that of the actinium. Such evidence as is available does not tend, in the present writer's opinion, to support this view.

ZOOLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

JOURNEYS OF LIMPETS.—Without troubling himself with the records of previous observers, which he has not read, G. Billiard describes his observations of a particular shore pool. He marked a number of limpets, and had the satisfaction of proving that they went on the prowl for several yards and returned. They do not go on a journey when the sun is shining on the pool, but wait for dull weather or a shower.

PEDIGREE OF BIRDS.—Following Abel in part, Baron von Huene suggests that birds arose from Ornithischia at the stage of bipedal hopping creatures with backward turned pubes and other specialisations. They became climbers on trees; they acquired skin expansions or patagia, and practised swooping; they subsequently acquired feathers; and ultimately learned true flight. But we cannot yet tell how a Silver Wyandotte evolved from a Jungle Fowl!

REMARKABLE SEX DIMORPHISM.—Allan R. McCulloch calls attention to two Australian Pipe-fishes, *Stigmatophora argus* and *S. nigra*, in both of which the males carry the eggs in pouches, as is usual in the family Synnathidae. But, while there are no very striking differences in the form of the body in the two sexes of *S. argus*, the male and female of *S. nigra* are so dissimilar in their appearance that one can only be sure of their specific identity after a critical comparison of all their characters. The male is sub-cylindrical and almost without ornamentation, while his mate is broad and depressed, with rich pink and black markings.

HAIR OF CAT.—Like many other mammals, the cat has three kinds of hairs. They have been recently studied in great detail by Dr. Hermann Hofer: (1) There are the long, strong, prominent hairs, never wavy, ending in a fine point. (2) There are shorter, wavy hairs, with alternate broader and narrower portions, ending in a more abrupt point. (3) There are woolly hairs, delicate, fine, and undulating, with very little pigment. The three kinds of hair differ markedly in their covering of cuticular cells. In the unborn kitten the hairs occur in obvious groups of three—a median hair and two lateral hairs. Later on, the lateral hairs increase in number, and they are accompanied by accessory hairs. The groups are disposed in longitudinal rows. The median hairs become (1), the lateral hairs (2), and the accessory hairs (3).

FAUNA OF COAL-PIT AT GREAT DEPTHS.—Dr. James Ritchie reports thirteen different species at a great distance from the surface, and notes that these probably represent only a fraction of the denizens of the pit. Their chief interest is in illustrating the "toughness" of life and the early stages in the formation of a cave fauna. The collecting-ground was at a depth of seven hundred and fifty feet at Niddrie, in the Midlothian Coalfield. There was no adjacent ventilating shaft to the surface, and the main shaft was about a quarter of a mile away. Most of the animals must have come in with the props of Norwegian fir, which support the roof and walls of the working, and with the horse fodder. Some of the light-bodied creatures may

have been swept in by the ventilating currents. No special modifications were observed. The list includes: The Common Mouse, the Brown Rat, the House-sparrow, the Great Slug (*Limax maximus*), a Small Spider (*Lessertia dentichelis*), two Beetles, two Flies, a Springtail or "Pit-flea" (*Tomocerus minor*), two Earthworms (*Eiseniella tetraedra* and *Helodrilus* [*Dendrobaena*] *rubidus*), and a Mycetozoon (*Stremonitis fusca*) on the pit props.

A BIRD IN A SPIDER'S WEB.—In a letter to Professor Poulton from the islands in the north-west of the Victoria Nyanza Dr. G. D. H. Carpenter writes (*Trans. Entomological Soc.*, 1914, Part II): "Several islands have an unpleasantly large number of enormous spiders' webs, in which I have seen a sun-bird caught fast. The webs form sheets, stretching across open spaces from tree to tree, and not in one plane only. Numbers of them are spun one behind the other so closely that one wonders how on earth the owners of the middle webs ever get anything to eat! And, indeed, many of them look half-starved! Yet, on other islands near by, the species seems hardly able to hold its own: it is just there, and that is all one can say."

DINOSAURS NOT A NATURAL ORDER.—In 1888 Seeley maintained that Owen's order Dinosauria should be split into two, Saurischia (=Theropoda + Sauropoda) and Ornithischia. Baron von Huene has recently corroborated this view, and maintains that the Dinosaurs are not monophyletic. The Saurischia and Ornithischia differ markedly as to hip-girdle and skull. Moreover, in the vertebral column, Saurischia of the highest degree of specialisation do not possess ossified tendons as do all bipedal Ornithischia, a difference probably correlated with different ways of feeding and moving. Abdominal ribs are not known in Ornithischia. Von Huene maintains that Saurischia and Ornithischia came from the Pseudosuchia, the former directly from their most primitive representatives by minor specialisations, the latter from most advanced representatives by a stage of bipedal hopping creatures, in which the pelvis became adapted to this new locomotion by a turning back of the pubis, as in birds, and the development of a praepubis.

PORPOISES IN CAPTIVITY.—The New York Aquarium is unique in having a school of Porpoises (*Tursiops truncatus*) living in captivity in good condition. The Director, Mr. Townsend, has made some interesting observations on their habits. They are quieter at night, but they seem to swim continuously. "A Porpoise, speeding around the pool, can make a right-angled turn as quickly as a frightened fish without lessening speed." All food is swallowed under water, but they often play with a dead fish, throwing it away for five to ten feet and catching it again. They often appear to play, "darting with mock ferocity after each other." The ordinary swimming motion of the tail is up and down, but there seems sometimes to be a side action. The flippers are used in turning movements. They often swim on their backs. There is considerable mobility of the short neck. There is no evidence that they can see out of water. Mating was observed in January and again in March and April, and the Director has some expectation that they may breed. The five Porpoises in the Aquarium consume about ninety pounds of fresh fish in a day. The average length of this Dolphin is about eight feet, and the average weight about three hundred pounds. The species, *Tursiops truncatus*, or Bottle-nosed Porpoise, has a wide distribution, occurring in many parts of the North and South Atlantic and the Mediterranean, as well as in the Indian Ocean and off New Zealand.

CURIOUS HABIT OF COCKATOOS.—W. W. Froggatt has some interesting notes on the Rose-coloured Cockatoo, or Galah (*Cacatua roseicapilla*), of New South Wales. When they come to slake their thirst at the water-holes they are fond of alighting on any post that may be in the water, and it is a curious sight when half a dozen together crawl down it to drink and stand on their heads. They have a quaint

way of talking or grumbling to themselves in a low tone, often for an hour or more, before they go to sleep. They nest in hollow trees, and sometimes peel the bark off the branch below the nesting-hole. Lucas and Le Souef speak of this as general, but Froggatt found it only in a few. The bark was stripped off an area about a foot wide and two feet long, just below the openings. The branch was never ringed all round. The bushmen say that the Galahs do this to make the stem so smooth that the Monitor Lizards cannot creep round to rob the nest. As these Lizards are not plentiful in the scrub country where Froggatt made his observations, it is possible that the habit falls into abeyance when there is no need for it.

EFFECT OF POSTPONED MOULT.—C. W. Beebe (*Zoologica*, Vol. I, pp. 253–8, 1914) redescribes his important experiments on the “Effect of a Postponed Molt upon the Sequence of Plumage in certain Passerine Birds.” In the cock Scarlet Tanager (*Piranga erythromelas* Vieillot) the brilliant scarlet nuptial plumage gives place at the autumn moult to an olive-green winter dress, and is reassumed at the spring moult. The autumn moult is normally associated with the thin and poor condition which follows the breeding season; but in these experiments tame birds which had not bred were placed under observation at midsummer. The

light was gradually cut off, and the food supply augmented: the birds became quiet and inactive, and rapidly put on fat. Under these conditions no autumn moult took place, and it was therefore concluded that the condition of fatness or thinness of the bird's body influences the moult. The striking fact was that the birds retained their nuptial moult till the following spring, and then, on being gradually brought under normal conditions, moulted directly into their new summer dress without any intervening green plumage. “We have thus proof that the outward manifestation of the sequence of plumage in these birds is not in any way predestined through inheritance bringing about an unchangeable succession . . . of scarlet green, scarlet green, year after year.” It is, however, supposed that, while the birds' condition postponed the moult, the “pigmental changes in the blood” took place as usual, but were not apparent because there were no new feathers to be coloured: one Tanager which was exposed to a sudden temperature change lost weight rapidly, and underwent a belated moult into the green winter plumage. In those which did not moult till spring the green potentiality must have similarly existed, but it was succeeded by the scarlet plumage without ever finding expression. Bobolinks (*Dolichonyx oryzivorus* Linnaeus) were also brought from one nuptial dress to another without any intervening winter plumage.

REVIEWS.

CHEMISTRY.

A First Book of Chemistry.—By W. A. WHITTON, M.Sc. 150 pages. 74 illustrations. 7-in. × 4½-in.

(Macmillan & Co. Price 1/6.)

This little book is arranged on an excellent plan, for each chapter opens with a series of experiments, most of which can be carried out by a young student, and then explains in simple language the deductions to be drawn from the experiments. Thus, from the very first, the beginner is taught to test every statement, and to take nothing for granted. The subjects include solution, combustion, the principal common elements and their compounds, and the laws of chemical combination. Some account is also given of various manufacturing processes, involving the application of chemical reactions. The book is well illustrated by drawings of apparatus and plant, and exercises are appended to each chapter. It should not fail to make the learner want to continue the study of chemistry.

C. A. M.

A Manual of Practical Physical Chemistry.—By T. W. GRAY, M.A., D.Sc. 211 pages. 61 illustrations. 7½-in. × 5-in. (Macmillan & Co. Price 4/6.)

Instruction in practical physical chemistry presents many difficulties where young students are concerned, for much of the work is tedious and difficult to compress within the limits usually assigned to it in a school course. The author is therefore to be congratulated upon his suggested series of exercises, each of which can be finished within two or three hours; and for this reason this little handbook will be found almost as useful to teachers as to students. The usual subjects, including molecular weight determinations, vapour pressure, density, optical activity, and electromotive force, are dealt with at length, the different forms of apparatus being fully described and illustrated with diagrams, while a series of tables of useful data and logarithms is appended.

Curiously, although reference is made to the melting-points of organic compounds, no description is given of the various methods of determining the constant, and of the corrections to be applied to obtain the true melting-point. This is an omission that might with advantage be made good in the next edition.

C. A. M.

The Chemistry of the Radio-Elements. Part II, “The Radio-Elements and the Periodic Law.”—By F. SODDY, F.R.S. 46 pages. 11 diagrams. 9-in. × 6-in.

(Longmans, Green & Co. Price 2/- net.)

In no branch of chemistry has progress been more rapid and more striking than in its latest offspring, radio-chemistry. It is barely three years since the subject was fully dealt with in one of these “Monographs on Inorganic and Physical Chemistry,” yet a continuation is needed to cover the advances made since Part I was published. The theories that were then put forward tentatively as to the genetic relationship of the radio-elements and their position in the periodic table are now supported by a mass of experimental evidence, and much light has been thrown upon the laws that govern the disintegration of one element into another. An outline of each important discovery has been given in “KNOWLEDGE” at the time, but all who are interested in the subject will be glad to have this lucid survey of the whole ground. Some idea of the scope of the book may be gathered from the section headings, which include: The Nature of the End Products, The Origin of Actinium, Neon and Metaneon, Nature of Isotopes, The Structure of Atoms, The Nature of the Argon Gases.

After discussing the atomic weight of lead and the evidence pointing to the chemical identity of radium-D and lead, the author alludes to the dream of the alchemists in the following words: “It is of interest to note how nearly science has approached to the solution of the problem of the alchemists. If thallium could be made to expel an α -particle, or mercury one α - and one β -particle, the product would be isotopic with gold. Though, of course, this is not yet possible, there can be little doubt that success would follow the application of sufficiently great electric potentials of the order of some millions of volts. So far as can be seen, all insulating media, even a perfect vacuum, fail at potentials far short of this, conceivably by such disintegration of the material of the electrodes.”

C. A. M.

Chemical Calculations.—By H. W. BAUSOR, M.A. 136 pages. 7-in. × 5-in.

(W. B. Clive. Price 2/-.)

In this little book the calculations which are inseparable from chemistry from its very beginnings are dealt with concisely, yet at sufficient length to make them clear to a young student. The subject matter is more elementary

than in the case of the companion book recently noticed in these columns, and it may be recommended to all who are beginning the study of the science. The subjects include the metric system, laws of gases, determination of chemical formulae, chemical equations, and examples of gravimetric and volumetric analysis, and at the end there is a helpful series of graduated problems and a table of logarithms.

C. A. M.

PAINTING IN NORTH ITALY.

The Painters of Italy: A History of Painting in Italy. Umbria, Florence, and Siena.—Vols. V and VI. By CROWE and CAVALCASELLE. Vol. V, 528 pages. Vol. VI, 220 pages. Numerous illustrations. 9-in. × 6-in.

(John Murray. Price 21/- each volume.)

While north, east, and west the hideous tumult of carnage is convulsing Europe, Italy lies serene and smiling among her olives, from the rocky, barren coasts of Calabria to the rich and busy haven of Genoa, immortal shrine of an art that shall soothe and illumine and ennoble the souls of men when the twentieth-century Herod has passed away like the smoke of his cannons. For the painters of no other country have known so to spiritualise the flesh as the painters of Italy; nowhere has the cult of the Madonna and Child been so perfected in art. Above countless altars, darkened by the smoke of centuries of worship, the Mother of God, patient and benign, with the Saviour upon her knee, smiles down upon her votaries the eternal promise of peace and forgiveness, while her courtly circle of adoring saints and ascetics bring home as nowhere else the message that "God was made man, and dwelt among us." Thus at this time there is a curious appropriateness in the appearance of the last two volumes of Crowe and Cavalcaselle's "History of Painting in Italy," completing the new authorised edition, for which we have waited so many years; for the minds of all of us turn with relief from a chaotic world to those calm, lofty, and immutable ideals which the Italian painters realised. These two concluding volumes deal with those ideals in some of their most exquisite manifestations, for they treat of the delicate and elusive charm of the painters of Siena and the robust school of Umbria. Merely to turn the pages of these beautiful volumes and study the illustrations is an education in itself. The editors, Mr. Langton Douglas and Mr. Tancred Borenius, have admirably preserved the homogeneous character of the work as a whole. The writers' text stands untouched, careful footnotes drawing attention to the minor points on which modern criticism, in the light of more recent discoveries, is not wholly at one with their conclusions. For the work of Crowe and Cavalcaselle stands for all time supreme of its kind in comprehensiveness, discernment, and appreciation. The last two volumes cover that glorious period beginning with the name of Piero della Francesca, Perugino, Pinturicchio, and concluding with that of Andrea del Sarto. In one of those illuminating and suggestive summaries which occur from time to time in their work the authors comment on the perfecting influence of Florence on the great artists of her day: "Its ultimate perfection was due to the wisdom with which all existing elements of progress were assimilated and combined. The great laws of composition founded on the models of Giotto, the plastic element made dominant by the sculptors of the fifteenth century, the scientific perspective of lines which owed its impulse to Uccello, the more subtle one of atmosphere which Masaccio mastered, the tasteful architecture revived by Brunelleschi and Alberti were summed up in a great measure by the spirit and grasp of Domenico Ghirlandaio." In such passages as these is kept before the reader's mind the ordered continuity of the development of painting in Italy. It is the realisation of this which helps to give its value to the work as a whole.

E. S. G.

TIMBER.

The Mechanical Properties of Wood.—By SAMUEL J. RECORD, M.A., M.F., Assistant Professor of Forest Products, Yale University. 165 pages. 50 illustrations. 7-in. × 5-in.

(New York: John Wiley & Sons. London: Chapman and Hall. Price 7/6 net.)

Professor Record is already favourably known as a student of timber, and this eminently practical handbook will unquestionably add not a little to his reputation. In spite of the formidable-seeming bibliography that he gives us, occupying fourteen pages, there was a distinct want of a comprehensive and simple manual such as this. The uninitiated would perhaps hardly realise that the mechanical properties of wood can be analysed into no fewer than nine principal and distinct characters, namely, elasticity, tensile strength, compressive strength, shearing strength, bending strength, toughness, hardness, cleavability, and resilience. Still less does the ordinary carpenter, builder, or other employer of wood for purposes of construction realise the complexity of the apparatus necessary to test these qualities. It is only in Government departments, or in the most richly endowed engineering institutes, that we can expect such machinery to find a place; so that it is not surprising that Professor Record's book, although not a Government publication, is largely made up of data obtained by the United States Forest Service at their Laboratory at Madison. Few, if any, Governments are more deeply interested in the commercial value of home-grown timbers than is that of the United States; and the scientific world is much indebted to that Government for the thoroughness with which it carries out such investigations as these. The chief drawback to them at present is that which has always beset timber-testing, namely, the variety of tests applied by different investigators for the same objects, by which their results are rendered almost incapable of comparison. The common names of American trees are now becoming fairly definite on their side of the Atlantic, or we should have insisted that "beech, sugar maple, post oak, longleaf pine," and so on, ought to be supplemented with the scientific names of the species intended. As it is at present barely possible to compare English, Indian, Australian, and Continental tables of tests with those of the United States, is it too much to ask that the well-equipped United States Government should obtain a good series of well-authenticated samples of European, Indian, and Australasian timbers, and submit them to tests identical with those already employed for their native timbers, so that they might happily appear in some future edition of Professor Record's book? We believe that the result would redound to the commercial profit of America. The Professor has placed his students under an additional obligation by reducing the mechanics involved in his work to the simplest terms, without reference to higher mathematics. The photographs of the testing machines are perhaps not very illuminating, but they are supplemented by an excellent series of diagrams in the text.

G. S. BOULGER.

ZOOLOGY.

The Romance of the Beaver.—By A. RADCLYFFE DUGMORE. 225 pages. 102 illustrations. 9-in. × 5½-in.

(Wm. Heinemann. Price 6/- net.)

What he has done for the Newfoundland caribou in an earlier volume Mr. Dugmore has accomplished in the one now before us for the Canadian beaver; but, as the latter is a distinctly more interesting and more wonderful animal than the former, his new venture should appeal to a still larger circle of readers. That a number of misconceptions and errors regarding the habits of an animal that stands alone in the matter of mechanical ingenuity, and in the

extent to which it has modified the landscape over vast tracts of country, should have sprung into existence is small matter for wonder; and it is particularly satisfactory that the author has been at great pains, as the result of his large personal experience, to get at the truth in such cases.

One of the points in dispute is whether beavers plaster over their "lodges" (*i.e.*, their dwelling chambers) with mud dredged from the bottom of the pools in which they are built. Some observers have stated that the lodges are roofed only with sticks; but, although he admits that this is often the case in the earlier part of the season, Mr. Dugmore states that in most cases which have come under his own observation they are thickly daubed at the commencement of winter with mud, which is, of course, soon frozen hard. Very remarkable is the statement that a beaver's couch of wood-fibre in the lodge is always kept perfectly dry, despite the fact that the owner has to effect an entrance under water, thus indicating that the animals must have some means of drying themselves before resorting to their beds.

Far more extraordinary is, however, the author's theory that beavers designedly construct a ventilating apparatus in the lodge, either in the form of a thin patch in the roof or, when the structure is built round a tree, in the shape of a chink at the junction of the roof with the latter. "The very idea of making provisions for ventilation," remarks Mr. Dugmore, "is one of the many exhibitions of the clever animal's thoughtfulness. The existence of these ventilation flues has sometimes been questioned, but it has been more or less clearly exhibited in all of the many scores of lodges which I have examined." That such apertures do exist may be freely admitted, but this is far from convincing us that the beaver constructs them with a definite knowledge of their effect as ventilators, more especially when we recall, as the author mentions, that the beaver's brain is of a low type, even for a rodent.

Such psychological opinions do not, however, in any way detract from the general excellence and interest of

this beautifully illustrated volume, which we may confidently recommend to the best attention of our readers.

R L.

Zoological Philosophy.—By J. B. LAMARCK. Translated, with an introduction, by HUGH ELLIOT. 410 pages. 9-in. x 6-in.

(Macmillan & Co. Price 15/- net.)

It is surprising how long it often takes for a mistake to be corrected owing to one author copying from another, and half-truths are liable to be handed down for an even longer time, especially when they refer to a man's opinions. This is because in our days of hurry few have the time or take the trouble to read what was originally written, particularly when the words belong to a foreign language.

Now that Mr. Hugh Elliot has translated Lamarck's "*Zoological Philosophy*," and written an introduction which is a valuable summary of the views expressed in it, there is really no excuse for anyone to look upon Lamarck merely as a zoologist who believed, what few do now, that acquired characters are inherited. Mr. Elliot would be the last to deny that Lamarck considered the inheritance of acquired characters to be one of the main factors of evolution, but the fame of Lamarck depends upon the fact that he believed in evolution fifty years before Darwin's "*Origin of Species*" appeared, and, further, to use Mr. Elliot's words, "he defended the doctrine of organic evolution at a time when it was opposed, not only to the entire authority of the Church and people, but also to the judgment of the leading men of science. For half a century, his writings stood as almost the only public representation of a belief which no one now questions."

After giving a most interesting account of Lamarck's life, Mr. Elliot reviews his zoological work, goes into details as to his ideas on evolution and the advances he made in classification, and discusses his physiology and psychology. We have also to thank Mr. Elliot for giving us a literal translation of the "*Zoological Philosophy*," and at the same time for breaking up some of his ponderous sentences.

W. M. W.

NOTICES.

OUR MICROSCOPICAL COLUMN.—We have great pleasure in announcing that in future the Microscopical Column in "*KNOWLEDGE*" will be conducted by Mr. J. E. Barnard, F.R.M.S.

CLASSES IN PHOTOGRAPHY.—Mr. Edgar Senior's classes in photography begin again on Tuesday, January 12th, 1915, at the Battersea Polytechnic, and on Monday, January 11th, at the South Western Polytechnic.

GEOLOGICAL AND MINERALOGICAL BOOKS.—Messrs. John Wheldon & Co. have issued a classified catalogue of second-hand books, to the number of nearly a thousand, dealing with mining, geology, and palaeontology. It is so arranged that the titles of works dealing with any particular subject can be read through at once.

NATURAL HISTORY PHOTOGRAPHY.—We have received a catalogue from Mr. Armytage Sanders, which reminds us that he is still supplying his special cameras for natural history photography from 26, Charing Cross Road. He also undertakes all kinds of photography, lantern-slide making, and caters for the requirements of lecturers.

FOREIGN BOOKS ON SCIENCE.—We learn from *Nature* that arrangements have been made whereby books published outside the United Kingdom which are reviewed in its columns shall be on view at the offices of that paper, St. Martin's Street, W.C., for six months (after the reviews have appeared) freely to anyone who cares to call and see them. The step has been taken owing to enquiries that

are continually being received, and it is hoped that many men of science will welcome the opportunity thus afforded to them.

SECOND-HAND INSTRUMENTS.—The sale of second-hand apparatus by Mr. C. Baker has now reached such an importance that it has been found necessary to separate that dealing with photographic work from the rest. The present issue of the classified list still, however, contains ten sections, and describes instruments and accessories used in microscopy, surveying, astronomy, and advanced physical research. Field glasses and books are also included, and a list is added of instruments and apparatus wanted in the various sections.

FLIGHT - LIEUTENANT LAN - DAVIS.—Flight-Lieutenant C. F. Lan-Davis, who is a director of Messrs. J. H. Dallmeyer, Limited, well known to our readers as the makers of photographic and cinematograph lenses, has had a lucky escape from drowning. We learn from the *Daily Chronicle* that, while flying about ten miles from Yarmouth, his *aéroplane*, which is attached to Yarmouth Air Station, was completely smashed up through the bursting of the engine. The *aéroplane* dropped into the sea, and the North Shields drifter "*Noreen*" saved the lieutenant and his mechanic, Hendry, bringing them to Crossley Hospital, Yarmouth. When the *aéroplane* fell, Hendry swam clear, but Flight-Lieutenant Davis was unable to do so, being strapped in his seat. Hendry, however, gallantly dived underneath the *aéroplane* and unstrapped the airman, who was rescued only just in time by the "*Noreen's*" boat.

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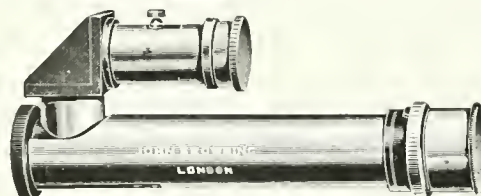
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Readers of "Knowledge" may like to have their attention directed to the following topical articles which have appeared in recent issues of NATURE:-

"Openings for British Chemical Manufacturers" (September 17); "Glass for Optical Purposes" (October 1); "The Cultivation of Medicinal Plants in England" (October 15); "The Sea Fisheries and the War" (October 22); "The Place of Science in Industry" (November 12); "The Supply of Pitwood"; "Effects of the War on Scientific Undertakings" (December 10); "High Explosives in Warfare" (December 24); "Optical Glass and Scientific Instruments: United Kingdom Imports and German Exports" (January 7).

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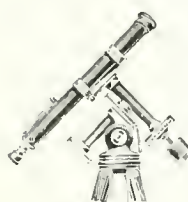
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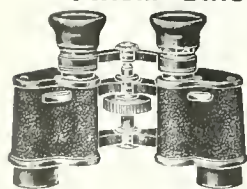
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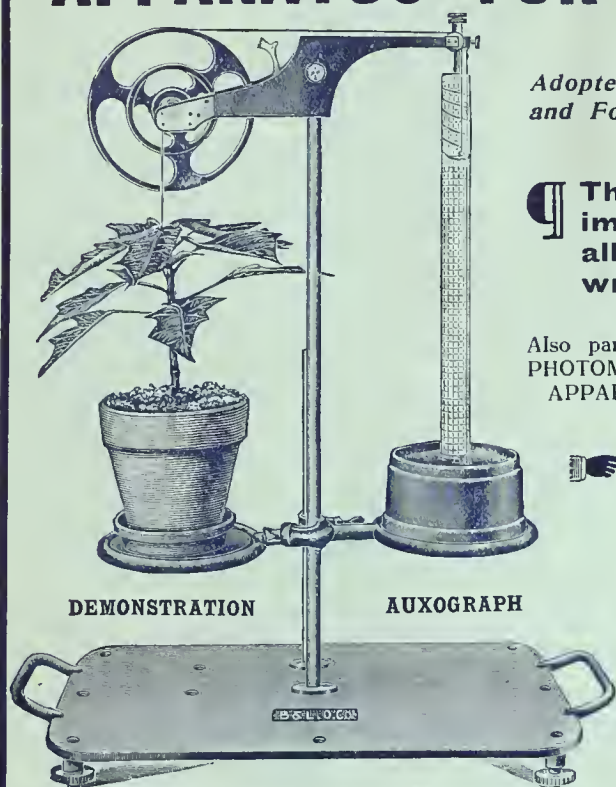
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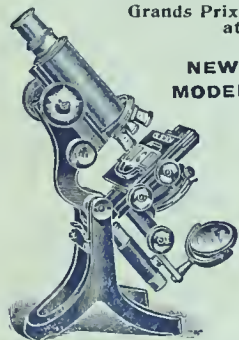
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